# REPORT RESUMES

ED 003 740 64

INSTRUMENTATION FOR INSTRUCTION, 1955-70, VOL. 3--TEXT.
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REPORT NUMBER NDEA-VIIB-069-3 PUB DATE 60
EDRS PRICE MF-$0.18 HC-$4.64 116P.

DESCRIPTORS- *INSTRUCTIONAL AIDS, *PROGRAMED INSTRUCTION, *TEACHING MACHINES, *EDUCATIONAL EQUIPMENT, AUDIOVISUAL AIDS, INSTRUMENTATION, DISTRICT OF COLUMBIA, TECHNOLOGICAL DEVELOPMENT PROJECT

INFORMATION FOR PLANNERS OF NEW SCHOOLS AND INSTRUCTIONAL SYSTEMS ON EDUCATIONAL INNOVATION AS WELL AS INFORMATION FOR TEACHERS, PRINCIPALS, AND ADMINISTRATORS ON PRESENT TECHNIQUES AND TRENDS WAS PRESENTED. THIS VOLUME INCLUDED MATERIAL ON PHOTO-MECHANICAL COPY PROCESSES, TESTING, TEST SCORING, PROGRAMED INSTRUCTION, AND TEACHING MACHINES. OTHER VOLUMES IN THIS SERIES ARE ED 003 738 THROUGH ED 003 746. (LP)

ED003740

069

FINAL REPORT

TECHNOLOGICAL DEVELOPMENT PROJECT

INSTRUMENTATION FOR
INSTRUCTION: 1955-1970

Draft Copy for Editing

VOLUME III - TEXT

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
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# VI

# PHOTO-MECHANICAL COPY PROCESSES

One of the major functions of the school is to transmit information to each new generation~~s~~ of students. It would follow that schools should have some equipment for duplicating and copying printed matter to supplement the materials available in texts and workbooks. Most schools have a spirit duplicator or mimeograph for this purpose, and usually it is necessary to type or write the information on special stencils for use in these devices.

Improved office copy machines which copy directly from books or other existing materials are of potential value for instructional purposes. Where copies can be produced for a few cents a page or less, direct copying may become~~s~~ competitive with duplication if the time required to prepare the master is considered. The office copier is valuable wherever a good original copy already exists; the duplicator excells for teacher prepared materials since the master copy can just as easily be made on the duplicator stencil.

Microcopying is of growing importance in the library field, and for condensed storage of school and business records. A range of equipment now exists for storage and retrieval of microfilmed documents, including viewers and copiers to scan and print out relevant materials.

Means are also being devised to transmit copies ~~of~~ by facsimile link so that full size or microfilm originals can now be transmitted by wire.~~witout the need for human transcription.~~ It should be noted that transcribing by hand or typewriter is slow, and apt to introduce errors. Photo-mechanical copies are direct facsimiles of the original and do not need proofreading and correction.

## A. Duplicators for school use.

Since mimeograph and spirit duplicators have been used by schools for many years, there is not reason to make a detailed listing here. Duplicators will only be mentioned in terms of new applications since 1955. These are principally

(466) GEHA

(467) GESTETNER

in the area of automatic production of masters by photographic or photo-mechanical means.

For example, existing copy or pasteups can be scanned line by line to etch a mimeograph stencil, and equipment for this purpose is manufactured by Geha (46), Gestetner (47), ~~and Rex ( ).~~ Masters for spirit duplicators can be produced by a heat process, and the materials are manufactured by the Ditto Company, + Minnesota Mining. Inexpensive paper masters for photo-offset machines can be produced on Verifax and similar machines. It would seem that these processes could save a considerable amount of time for the teacher.

B. Office Copiers

Office copy machines can be ~~a boon~~ of great help to the teacher for copying sections out of books and newspapers for distribution to the class. These devices vary from simple hand operated to fully automated machines with the facility to enlarge or reduce the size of the copy. Typical cost at at the present time run from one to five cents a page.

Most copy machines require the copy paper to be held in direct contact with the original and exposed to light or heat. Heat processes expose and develop the image in the same operation, while photographic methods require a short chemical development - usually ~~about fifteen~~ about twenty seconds. ~~or so~~. There are ~~xxxxx distinct~~ four photographic methods. Some produce a silver image (Photostat, ~~Verifax~~ A.B. DICK., Royfax, etc), some involve azo dyes (Ozalid), a few utilize physical deformation of the photosensitive material to make it opaque (Kalvar, Photo-Plastic, etc), while many of the more complex systems use pigments deposited by electrostatic methods and fixed by a flash heating process (Xerox, Apeco, Bruning, A.B. Dick, etc.) Table gives information on many of the existing copy systems.

# OFFICE COPY MACHINES

| | Negative image | Positive image | Contact copying | Optical Copy (enlarge or reduce) | Silver emulsion | Azo dye | Heat sensitive | Ultraviolet-Infrared (Kalvar) | Electrostatic | For line copy | will reproduce halftones | will reproduce photographs | can be used to make offset masters |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| American Photocopy (APECO) | | X | X | | | | | | X | X | | | X |
| Ampto | | X | X | | X | | | | | X | | | X |
| Anken Chemical | | X | X | | | X | | | | | X | | |
| Bruning | | X | X | | | | | | X | X | | | |
| Copease | | X | X | | X | | | | | X | | | X |
| Copy Research | X | X | X | | | | | X | | | | X | |
| A. B. Dick | | X | X | X | X | | | X | | X | | | X |
| Eastman (Verifax) | | X | X | | X | | | | | | X | | X |
| General Analine (Ozalid) | | X | X | | | X | | | | X | | | |
| Minnesota Mining (Thermofax) | | X | X | | | | X | | | X | | | |
| ~~Photomaster~~ | | ~~X~~ | ~~X~~ | | ~~X~~ | | | | | ~~X~~ | | | ~~X~~ |
| Photorapid | | X | X | | X | | | | | X | | | X |
| Photostat (Itek) | X | | ? | X | X | | | | | | X | | X |
| Royal | | X | X | | X | | | | | X | | | X |
| Smith Corona | | X | X | | | | | | X | X | | | |
| Speedoprint | | X | X | | X | | | | | X | | | X |
| Transcopy | | X | X | | X | | | | | X | | | X |
| ~~Triangle~~ | | ~~X~~ | ~~X~~ | | ~~X~~ | | | | | ~~X~~ | | | ~~X~~ |
| Xerox | | X | | X | | | | | X | X | | | |

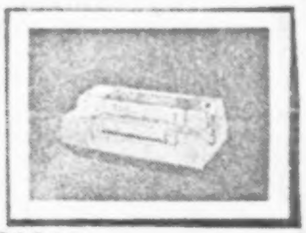
## OFFICE COPY MACHINES

(468) American Photo (APECO)

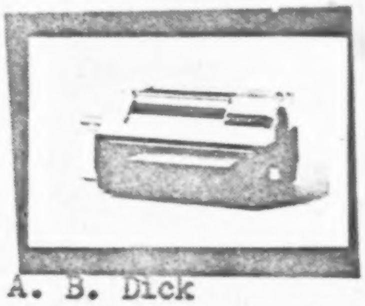
(469) Ampto

(470) Anken

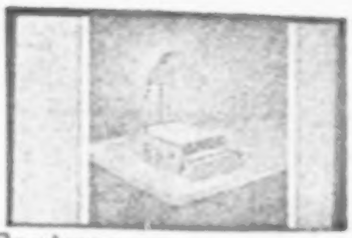
(471) Bruning



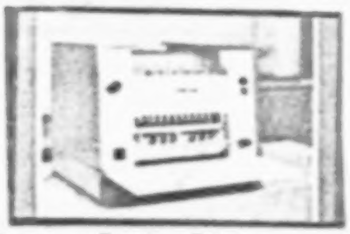
(472) Copease



(473) A. B. Dick



(474) Eastman



(475) General Analine

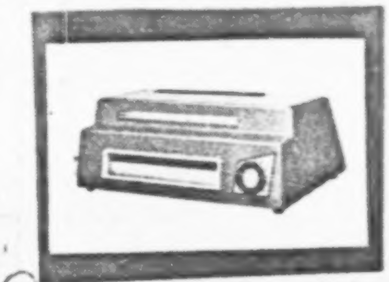
(476) 3-M Thermofax

~~PIC FILE~~

(477) Peerless

~~PIC FILE~~

(478) Photomaster



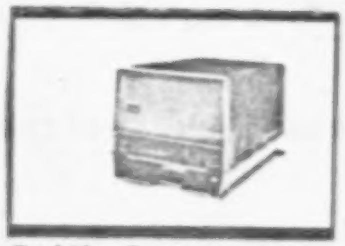
(479) Photorapid

## OFFICE COPY MACHINES (2)

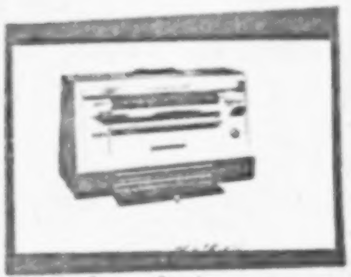
(480) Photostat

(486) Xerox

(481) Royal McBee



(482) Smith Corona



(483) Speedoprint

(484) Transcopy

~~PIC FILE~~

(485) Triangle

Office copy machines are excellent for black and white "line" copy, but are not well suited to photographs and continuous tone materials s~~uch as photographs~~ except for the "screened" prints found in newspapers and magazines. Special materials for direct copying of ~~half-tones~~ continuous Tone subjects are ~~KKK~~ manufactured by Copy Research ([illegible], Keuffel and Esser ([illegible]), and a number of similar processes are under development. These processes can be used to produce negatives, positive transparencies, and paper prints.

## C. Instant Photography

The Polaroid Land Camera (4&1) permits almost instantaneous production of prints and projection transparencies in black and white or in color. At the present time their major use in schools is ~~prx~~ for projection materials, but teachers are also finding ~~thx~~ photographs of value for recording class activities, or even to show the student where his performance falls down in certain physical skills.

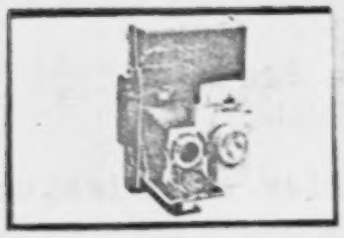


Fig. 487 Polaroid Camera. Instant photography allows the preparation of prints and transparencies at short notice.

Fig. 488 Printing device to make instant prints from existing negatives. (U. S. Photo)

Fig. 489 Even the conventional darkroom processes can now be expedited by rapid dry processing methods. ( Fotorite)

Polaroid also have a process which produces a negative as well as the print, and this negative is suitable for making high quality copies by normal photographic means. If rapid copies are needed the print can be rephotographed on Polaroid film, printed in an instant copier made by U.S. Photo (488), or quick processed after normal darkroom printing using the dry developing process perfected by Fotorite (489) Minnesota Mining have just introduced a fifteen second process using a modified "Filmac" microfilm reader printer, and then there are the Keuffel and Esser and Copy Research systems already mentioned. It seems that many new processes will be introduced over the next few years to speed and simplify photography and reduce the cost. Its immediate value for schools will be ~~in~~ for the production of ~~display~~ lesson materials. ~~but with some use for recording and direct instruction.~~

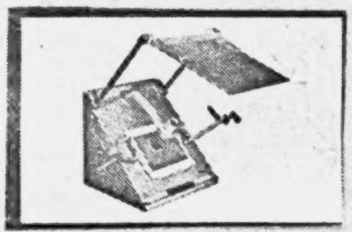
D. Micro-Copying.

Microfilm is an inexpensive storage medium which permits the storage of an enormous volume of information in a very small space. It would be conceivable to store microfilm copies of all the books and documents in the Library of Congress in a room twenty feet square. With modern storage and retrieval equipment it would also be feasible to locate a page in any given document in less than a minute. A wide variety of viewers are now available for direct reading from the microfilm copy, and printing processes which are often similar to those used in office copiers allow paper copies to be made as required. The simplest viewers are similar to the 35mm filmstrip projectors reviewed earlier, while the most sophisticated versions use a television link between the storage and retrieval unit and the viewer. Those devices using a computer will be discussed later. The simpler units are summarized in Table     and the pictorial directory.

MICROFILM READERS AND READER PRINTERS

~~Pic F~~

(490) American Optical



(491) AV Research

Pic File

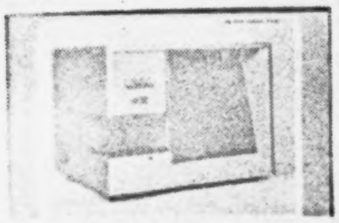
(492) Burroughs

"

(493) DeFlorez Co

"

(494) Documat



(495) Eastman

"

(496) Frederick Luther

~~"~~

(497) Griscombe

"

(498) Itek (Photostat)

"

(499) Microcard

~~"~~

(500) Microlex

(501) Microdealers Inc

# MICROFILM READERS AND READER PRINTERS

(502) Minnesota Mining (3-M)

PIC
FILE

503a — Polydex

(503) Opticopy

503a PFAFE

503b Photo Device Re Kodak

503c

PIC
FILE

(509) Western Blueprint

## E. Newer Storage & Duplication Media

Just as magnetic tape has simplified the recording and storage of sound and visual information, ~~xxx~~ processes now in the research and development phases promise to simplify microfilming, provide finer resolution, and allow instant development and checking as the materials are produced.

8a

Three years ago the General Electric company developed a process called Thermoplastic recording which used a heat sensitive plastic to impress an image directly on the film. Figure 506 shows how a whole encyclopedia might be stored as a tiny 8mm reel of film. The General Electric company have subsequently developed a light sensitive variety of this material and named it Photoplastic. Where light falls on the film it dissipates an electrostatci charge, and flash heat development causes the unexposed areas to become opaque. Both of these processes allow the film to be ~~The National Cash~~ erased and reused if required

The National Cash Register Company use a light sensitive dye in their Photo Chroic Micro Image (PCMI) recording. The

## MICRO-RECORDING PROCESSES

Fig. 505 8mm image on Thermoplastic film.

Thermoplastic has the advantage of instantaneous recording and erasure, with a visible image to facilitate viewing and editing with donventional motion picture equipment.

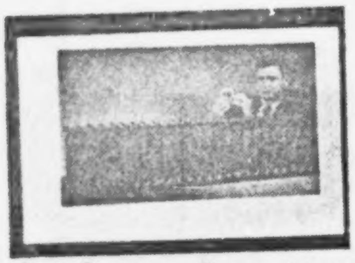


Fig. 506 This set of encyclopedias could easily be recorded on a 50ft rool of thermoplastic.

~~Sig.~~
Fig. 507 Checker-board pattern indicates the resolution possible with thermoplastic tape

Fig. 508 Photo Chroic Micro Image (PCMI) Film. The books in the girls lap have been photographically reduced onto the ~~pixx~~ sheet of PCMI film in her hand. the enlargemnt from the film behind her indicates the layout of the pages on the sheet of film.

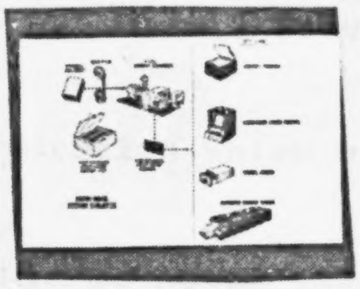


Fig. 509 Micro Image System Concept showing how automated and hand operated storage and retrieval systems could be set up using PCMI.

dye image is virtually grainless, allowing enormous reductions and very compact storage. The authors viewed samples of the material which had been reduced 64,000X, and the copy was still clear and readable. Figures 508 and 509 suggest how this material might be stored and utilized. For low cost duplication of micro-copies, the General Aniline and Dye Corporation supply Actifilm, an azo type film developed by ammonia fumes. A more recent discovery comes from the Kalvar corporation which uses heat development.

It should be noted that enormous improvements are also being made in regular photographic emulsions so that the newer recording media will not necessarily replace silver emulsions any more than videotape has replaced kinescopes or computers have replaced punch card machines. It would seem that many new possibilities exist with the new media. For example, the student could have a whole textbook printed on a single card, which could be erased and reused when he was finished with it. The real implications for school and college use are yet too far away to envision.

~~information not already considered, including teletype and facsimile, along with duplicating and copy methods for producing multiple copies of printed materials for classroom use.~~

## ~~E~~ F ~~B.~~ Teletype and Facsimile.

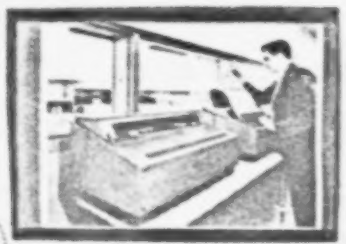
Teletype and facsimile are logical developments of the telegraph and photo-telegraphy. The Teletype allows information to be transmitted by means of a typewriter along telephone lines to another typewriter, and is widely used for the transmission ~~dissemination~~ of news, business communications, and telegrams. Such equipment is available through Western Union (518). Teletype requires a human typist to transcribe the message, but where a clear copy of the message already exists, ~~or where pictorial information is to be sent~~, facsimile is both faster and more accurate.

Facsimile copies do not require proof reading since they are exact replicas of the original, while printed-graphic and photographic information can also be sent by this method. Facsimile is widely used for distributing weather maps and

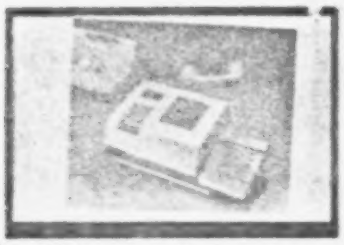
# DATA TRANSMISSION SYSTEMS

(510) **Alden**

(511) **Fairchild**



(512) **Litton**



(513) **Standard Register**

513a

(514) **Tally Register**

514 Teleregister

(515) **TelAutograph**

(516) **Victor**

(517) **Western Union**

(518) **Western Union**

for inter-office communications. It has great potential for transmission of documents and books between libraries and research institutions, and may one day be used for home news services giving the immediacy of television with the permanence and flexibility of print.

Companies manufacturing facsimile equipment include Alden,(510), Fairchaild (511 ), Hughes, ~~Hogan ( )~~, Litton (512), and Houston Fearless, TelAutograph (515)~~, and Western Electric~~

Victor (516) have a servo device for transmitting copies of hand-written information as it is written, while Standard Register (513) and Tally Register (514) supply equipment for transmitting punch card information over telephone lines. Their educational applications are not so immediately obvious as facsimile, yet it is probable that they will find a place in some school business offices in the near future.

8.12 - Transmission Systems

PIC FILE

FF+1? Proj Film Plat Board

NC12

concerned with

lability of

Polaroid Film ( ) for picture taking, and a method of making instant prints from negatives by U.S. Photo (   ) make the possibility more attractive than it used to be. For the audio-visual center, the ability to make instant photos, slides, and prints, may help to fill a long felt need.

## G ~~E~~. Future Developments.

It is certain that transmission media and copy methods will play a more significant role in education as time goes on. At the present the availability of equipment and the cost of both equipment and materials is a significant factor, but as tooling up is accomplished and costs are reduced, the requesting of a facsimile copy from a central library, or the generation of multiple copies for classroom use will become a routine proceedure.

New media and newer methods of transmission will

Fig. 519 The Laser is still essentially a research device, but its high information carrying capacity will make it highly significant in communications.

also play a part. The optical laser which is presently a curiosity of the research laboratory has the capability of transmitting the contents of a ~~dozen~~ hundred library books or a half hour television program in a tiny fraction of a second. As media and methods are developed, with the corresponding equipment for utilization, information will become more accessible to teacher and student. The Chapter on Computers will enlarge upon this aspect, since ~~the role of~~ modern data processing machines will also play an important role in making such innovations possible.

# COPY SYSTEMS

✓ A B Dick Company
5700 West Touhy Ave.
Chicago 48, Ill.

Addressograph-Multigraph
1200 Babbitt Rd.
Cleveland 17, Ohio

✓ American Photocopy Equipment Co.
2100 W. Dempster St.
Evanston, Ill.

✓ Anken Chemical & Film Co.
Newton, N.J.

ANSCO
Binghamton, N.Y.

AV Research

Bell & Howell Co.
7100 McCormick Rd.
Chicago 45, Ill.

Borroughs

✓ Charles Bruning Co., Inc.
1800 W. Central Rd.
Mount Prospect, Ill.

Contoura Photocopy Equipment
c/o Repco Photo Products Co.
2857 W. 9th St.
Los Angeles, Calif.

✓ Copease Corp.
425 Park Ave.
New York 22, N.Y.

Copy Research Corp
875 W. 15th Street
Newport Beach, Calif.

Council on Library Resources, Inc.
1025 Connecticut Ave.
Washington 6, D.C.

Cosmac - See Transcopy, Inc.

✓ DeFlorez Co., Inc.
200 Sylvan Ave.
Englewood Cliffs, N.J.

Ditto

✓ Documat
84 Fourth Ave.
Waltham 54, Mass.

✓ Eastman Kodak Co.
343 State St.
Rochester 4, N.Y.

✓ Fotorite, Inc.
6424 North Western Ave.
Chicago 45, Ill.

✓ The Frederic Luther Co.
P.O. Box 20224
2803 East 56th St.
Indianapolis 20, Ind.

Geha - See Milo Harding Co.

← General Analine & Film Corp, See Ozalid

✓General Electric Co.
Technical Products Operation
212 W. Division St.
Syracuse 3, N.Y.

Gestetner Corporation
Gestefax Division
216 Lake Ave.
Yonkers, N.Y.

✓Itek Business Products Division
Photostat Corporation
1001 Jefferson Rd.
Rochester 3, N.Y.

✓Kalvar Corp.

✓Keuffel & Esser Co.
Hoboken, N.J.

✓The Lawyers Co-operative Publishing Co.
Microlex Division
Rochester 14, N.Y.

✓Microcard Corporation
365 South Oak St.
West Salem, Wisc.

Microcopy, Inc.
3808 West 54th St.
Los Angeles 43, Calif.

✓Microdealers, Inc.
1560 Trapelo Rd.
Waltham 54, Mass.

← Microlex - See Lawyers Co-operative Publishing Co.

Milo Harding Co.
500 Monterey Pass Rd.
Monterey Park, Calif.

✓~~Minnesota Mining & Mfg. Co.~~
~~Department of Communication~~
~~2501 Hudson Rd.~~
~~St. Paul 19, Minn.~~

✓ Minnesota Mining & Mfg. Co.
Microfilm Products Division
2501 Hudson Rd.
St. Paul 19, Minn.

✓National Cash Register Co.
Electronics Div.
1401 East El Segundo Blvd.
Hawthorne, Calif.

✓ Ozalid Products
Photo & Repro Division
General Aniline & Film Corporation
Binghamton, N.Y.

✓ Pfaff Development Corporation
Marys La.
Huntington, N.Y.

✓ Photo Devices, Inc.
33 Litchfield St.
Rochester 8, N.Y.

✓ Photorapid
Box 1402, G.P.O.
New York 1, N.Y.

Photostat Corp. See Itek Business Product

✓ Polaroid Corporation
Cambridge 39, Mass.

Poly Repro International Lt
One Commercial Ave
Garden City, N.Y.

Polydex – see Poly Repro

✓ Readex Microprint Corporation
5 Union Square
New York 3, N.Y.

Recordak Corporation
415 Madison Ave.
New York 17, N.Y.

Regiscope Corporation of America
Suite 812
150 Fifth Ave.
New York 11, N.Y.

Remington Rand Systems
1220 East 42nd St
New York 17, N.Y.

~~Revere Camera Co.~~
~~2501 Hudson Rd.~~
~~St. Paul 19, Minn.~~

✓ Royal McBee Corporation
850 Third Ave.
New York 22, N.Y.

Smith-Corona Marchant, Inc
410 Park Ave.
New York 22, N.Y.

Speed-O-Print Business Machines Corp.
Chicago 13, Ill.

~~Standard Camera Supply Co.~~
~~756 Melrose Ave.~~
~~Los Angeles 46, Calif.~~

✓ Transcopy, Inc.
10 Paterson Ave.
Newton, N.J.

✓ U.S. Photo Supply Co., Inc.
6478 Sligo Mill Rd.
Washington 12, D.C.

Western Blueprint Co.
2415 W. Peterson Ave
Chicago 45

✓ Xerox Corporation
Rochester 3, N.Y.

## DATA TRANSMISSION AND FACSIMILE

✓ Alden Electronics & Impulse
Recording Equipment Co., Inc.
1 Washington St.
Westboro, Mass.

✓ Fairchild Camera and Instrument Corporation
5 Aerial Way
Syosset, Long Island, N.Y.

Houston Fearless Corporation
Westwood Division
11801 Olympic
West Los Angeles, Calif.

Hughes Aircraft Co.
P.O. Box 90515
Airport Station
Los Angeles 9, Calif.

✓ Litton Industries, Inc.
336 North Foothill Rd.
Beverly Hills, Calif.

Magnavox Co.
Magnavox Research Laboratories
2829 Maricopa
Torrance, Calif.

✓ The Standard Register Co.
Dayton 1, Ohio

✓ Tally Register Corporation
1310 Mercer St.
Seattle, Wash.

✓ TELautograph Corporation
8700 Bellanca
Los Angeles, Calif.

Teletype Corporation
5555 Touhy Ave.
Skokie, Ill.

✓ Victor Business Machines Co.
3900 North Rockwell St.
Chicago 18, Ill.

← Western Union Telegraph Co
60 Hudson St, New York 13, N.Y.

Westrex Company
Division of Litton Systems
540 West 58th St.
New York 19, N.Y.

IBM query

# VII.

# NEWER TECHNOLOGIES OF TESTING AND TEST SCORING

## A. INTRODUCTION

Testing is one of the principal means of evaluating student progress, ~~and~~ it also gives the teacher feedback on teaching effectiveness. The development of objective testing dates back to the beginning of the century when psychologists ~~adopted~~ developed this tool for ~~developing tests for~~ ~~Testing the~~ determining an Intelligence Quotient. Refinement of this ~~method~~ technique now makes it possible ~~the~~ to measure~~ment of~~ mental ability, interests, attitudes, aptitudes, and even personality. Widespread usage has enabled many of these tests to become "standardized" so that individual scores can be compared with national and local norms.

Objective tests use true-false, multiple choice, matching, and similar kinds of items to obtain a numerical score for each student. Errors due to guessing are compensated for mathematically to obtain a raw score, which ~~then~~ becomes a basis for comparison. Objective tests are quicker and ~~much~~ easier to score than essay tests because the factor of human judg~~e~~ment is built into the design of the test, and scoring becomes a mechanical operation. On the other hand, objective tests are more difficult to prepare, and must meet certain criteria. They must be valid and reliable, using specific and unambiguous questions to test each bit of knowledge. Also, the scores for an average class group should be widely enough distributed to facilitate grading. Validity implies that the test measures what it is intended to measure; reliability is the ability of a test to measure with reasonable accuracy under a wide variety of circumstances. Testing, through its alliance with psychology and statistical method, is now more a science than an art.

The development of superior testing tools has led, in turn, to an increased use of testing. The classroom teacher uses tests af regular intervals to evaluate progress, and ~~also as a source of motivation for the students~~. The same test questions can be used for succeeding classes periodically revised to meet changing needs. Objective scoring also makes it easy to compare the performances of classes from year to year, or classes taught by different teachers. New kinds of tests are continually being added so that ~~in the testing program~~ the scoring even of objective tests takes up a disproportionate amount of the teacher's time.

Some Testing bureaus ~~have been set up around the country for scoring standardized tests such as the Stanford-Binet, WISC, etc., and these~~ have elaborate machines for test-scoring. Simpler and less costly varieties are now becoming available for use in schools. Any scoring device which (uses) pencil-and-paper answer sheets will be referred to here as a test scoring machine. There are two other kinds of devices used in testing. One is a group response system where each student responds by means of push buttons to questions presented to the group. Another is the individual response unit, a machine which automatically tallies a student's responses, allowing him to work at his own rate. These last two testing devices can be adapted to inform the student if his ~~of the correctness of each~~ answer is correct immediately after the response is made. This is called the teaching machine response mode, and is dealt with more fully in the following chapter.

## A. Purpose.

Testing is a form of measurement used to evaluate both quantitative and qualitative aspects of human behavior. The test scoring machine is a device for scoring paper-and-pencil tests with a minimum of human effort. Objective tests make it possible to measure student progress and teacher effectiveness. Group response systems enable the teacher to integrate testing as a part of a regular lesson, automatically tally the score, and overcome the time lag between testing and knowledge of results. Individual response units allow each student to proceed at his own rate, ~~These units~~ tally the score, and are easily adapted to a teaching mode ~~by allowing the~~ ~~student~~ with immediate knowledge of results.

## 2. History.

The first commercially manufactured device for scoring paper-and-pencil tests was introduced by International Business Machines (IBM) in 1937, being preceeded by numerous custom-made devices used by various testing bureaus and colleges. The IBM device was highly flexible in operation and could grade up to one thousand papers an hour. ~~so that~~ Even today it is not outmoded after twenty-five years of use. ~~The only essential change from the IBM test scoring machine has been the~~ A recent trend has been the ~~subsequent~~ development of simple low-cost units for school use.

Sidney Pressey began work on a device for individually administering and scoring tests at Ohio State University in 1923, but the introduction of the first production model coincided with the beginning of the depression, so that, despite its merits, his discovery fell into obscurity and remained buried for over twenty-five years. It eventually gained prominence as a teaching machine rather than a testing device, employing the same principles Pressey had discovered thirty years earlier.

The group-response devices have been used in experimental studies ~~for~~ over nearly ~~twenty years,~~ XXX and the first devices were push-button arrangements used by members of a group or class to signal answers or opinions at specified times during a lesson. The modern counterparts have more answer buttons ~~so that~~ to enable a variety of responses. ~~is possible.~~ This kind of unit has become allied with the teaching machine movement, because of the ease of integrating the test items with the teaching program.

## B. TRENDS AND DEVELOPMENTS SINCE 1955

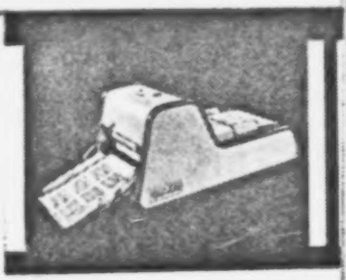
Except for the Pressey device and the IBM test scoring machine, the major innovation of test scoring devices has been in the years since 1955.

(367) BURGESS

Dates back to about 1950!

(368) ELECTRO - NETWORKS

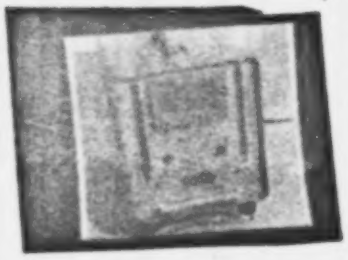
~~E-Z GRADER Co~~



(369) ELECTRONICS FOR EDUCATION INC

INTERNATIONAL BUSINESS MACHINES

(370)



(371)

SERCO

## TEST SCORING MACHINES

|  | reads pencil markings | reads punch holes | scores # answers correct | scores # answers incorrect | discriminates answers not attempted | places mark against wrong answers | totals score | applies loadings to scores | prints score on answer sheet | provision for item analysis | automatic feeding and stacking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Burgess |  | X | X |  |  |  | X |  |  |  |  |
| Electro-Networks | X |  |  | X | X |  |  |  |  |  |  |
| Electronics for Education | X |  |  | X |  | X | X |  | X |  | X |
| International Business Machines | X |  | X | X |  |  | X | X |  | X | X |
| Serco |  | X | X |  |  |  | X |  |  |  |  |

## 1. The Test Scoring Machine

The two essential functions common to all test scoring machines are the identification of correct and/or incorrect answers and counting devices to indicate the number of correct and/or incorrect answers. Most of the currently available ~~devices~~ units include additional features such as automatic feeding and stacking, printing the scores on the answer sheets, placing a mark against the incorrect items, a calculator or small computer to compensate for errors due to guessing, and some kind of memory unit to allow item analysis.

Most devices utilize the electrical conductivity of graphite in a "lead" pencil or photoelectric scanning of holes punched in a card. The former principle is used by Electro-Neworks (368), Electronics for Education (369), and International Business Machines (370), while the latter system has been adopted by Burgess (367) and Serco (371). The Electro Networks device uses a display of colored lights to indicate wrong answers (red) and unanswered questions (amber) which are counted manually. The Burgess machine (367) counts the number of correct answers automatically, while the Electronics for Education unit has automatic feeding and stacking, marks each wrong answer, and prints the total number of questions missed at the top of the answer sheet. The International Business Machines test scoring machine is the most flexible ~~of all,~~ and accommodates a variety of answer formats, counts both right and wrong answers, applies loadings and a variety of formulae to obtain the raw score, and as ~~well as keeping~~ makes an item count. Inserting the answer sheet into the counting unit and entering the score on the answer sheet is manual, but all other features are automated.

All of these test scoring units are both faster and more accurate than the human scorer, and with ~~the~~ ~~such~~ a variety ~~now~~ ~~available~~ to choose from it seems that many ~~more~~ schools will ~~be using these~~ ~~devices.~~ adopt~~ing~~ them in the near future.

### 2. Group response systems.

The simple push button units used by researchers to measure group characteristics and behavior have now been refined for classroom use, and facilitate both formal and informal testing. In a formal testing situation the questions would be presented to the class one question at a time, allowing sufficient time for the students to respond before proceeding to the next. The device is better suited to informal testing, where the teacher presents a teaching point and then asks a question. The student responds by pushing the appropriate button and a meter or display of lights informs the teacher how the class has performed.

All but one of the units currently available have the additional feature of immediate knowledge of results for the student, which makes them teaching as well as testing tools. These units will be described in the following chapter on teaching machines.

## 3. Individual Response Devices.

Many of the individual response units used for programed learning can also serve as self scoring devices for testing. Those response devices which use physically separate programs will be considered here as testing units. These include ~~punchboards~~ pull-tab arrangements or overlays which must be peeled off to disclose the answer, punchboards, and electronic punchboards.

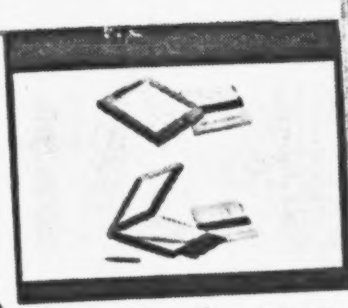
Management Research (377) ~~have developed~~ ~~supply~~ supplies? a series of cards with predetermined answer patterns ~~[illegible]~~ ~~xx~~ for self testing. The multiple choice answers are covered with pull tabs, ~~and these tabs~~ which must be ~~almost completely~~ removed to disclose ~~before~~ the answer, ~~is evident,~~ and ~~so that~~ "peeking" or "cheating" is ~~well~~ ~~nigh~~ almost impossible. Scoring is achieved by counting the number of tabs removed to get all answers right. Alternatively, numerical values can be assigned to the different ~~answers~~ choices so that the scores are loaded in terms of which answer is second best or third best. This same function is achieved ~~by~~ with the Trainer-Tester answer sheets of Renner (318) and Van Valkenburgh (379).

Here the answer is covered by a thin silver film which ~~must~~ is removed ~~be erased~~ with a pencil eraser ~~to discover the correctness of the choice~~. Again the method defies cheating, and the student can readily tally his own score. The silver overlay ~~offers a bit~~ is more flexib~~ility~~les than the pull tab method ~~because~~ ~~since~~ ~~it is a relatively simple matter to make up~~ for setting up special testing formats, ~~and the overlay is~~ ~~can be simply printed on~~. Also, many more questions can be accommodated on a single sheet of paper ~~than with the pull tab method~~ ~~compared to pull tabs~~.

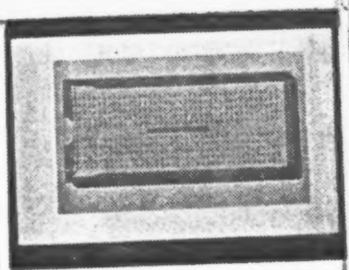
A variety of punchboards ~~are~~ is now on the market. ~~which give immediate knowledge of results and allow self scoring.~~ The simplest of these, made by Jensen (376), uses specially printed envelopes which enclose a pre-punched answer card. The student cannot see or feel which answer space covers the punch hole, and must ~~scribble~~ mark firmly ~~over~~ the center of the square he chooses. If his choice is correct, the pencil digs into the paper because of the punch hole underneath. If his choice is wrong he must ~~mark~~ make another ~~square by the same procedure~~ choice and continue until the correct answer is ~~determined~~ found. ~~More sophisticated~~ Other punchboards are available from Info-Tron (374) and Instrument Research (375). Both use ~~IBM~~

?

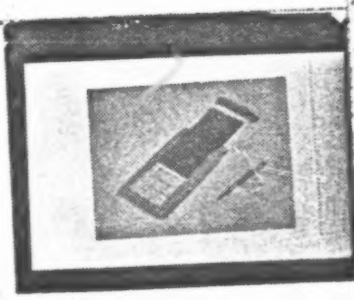
(372) A-ALPHA



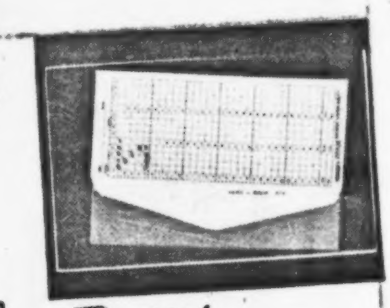
(373) GENERAL ATRONICS



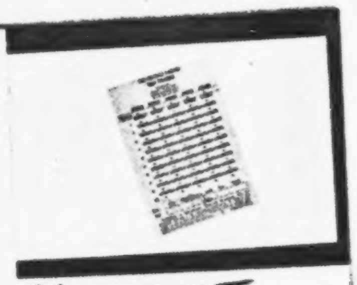
(374) INFOTRON



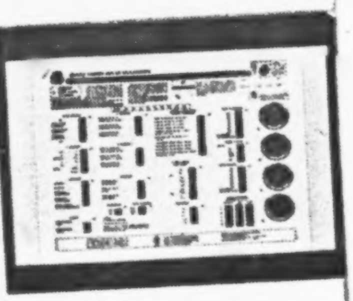
(375) INSTRUMENT RESEARCH.



(376) JENSEN

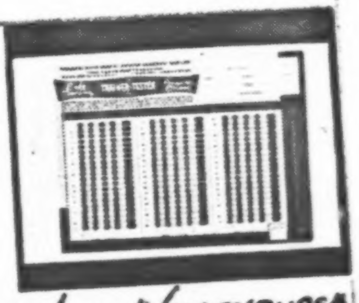


(377) MANAGEMENT RESEARCH



?

(378) RENNER



(379) VAN VALKENBURGH

# PUNCHBOARDS AND OTHER SELF SCORING TEST DEVICES

| | card sorter | Punchboard | Electronic Punchboard | Pull Tab | Erasible Overlay | student can score self | loaded scores | automatic scoring | teaching machine application |
|---|---|---|---|---|---|---|---|---|---|
| A-Alpha | | X | | | | X | | | X |
| Devereaux | | | X | | | X | | | X |
| Astra | | | X | | | | | X | X |
| Educational Specialties | | | X | | | X | | | X |
| General Atronics | | X | | | | X | | | X |
| HRB Singer | | | X | | | | | X | X |
| Infotron | | X | | | | X | | | X |
| Instrument Research | | X | | | | X | | | X |
| Larsen | | | X | | | X | | | X |
| Jensen | | X | X | | | X | | | X |
| Management Research | | | | X | | X | X | | X |
| NAK Inc | X | | | | | X | | | X |
| Renner | | | | | X | X | X | | X |
| Van Valkenburgh | | | | | X | X | X | | X |

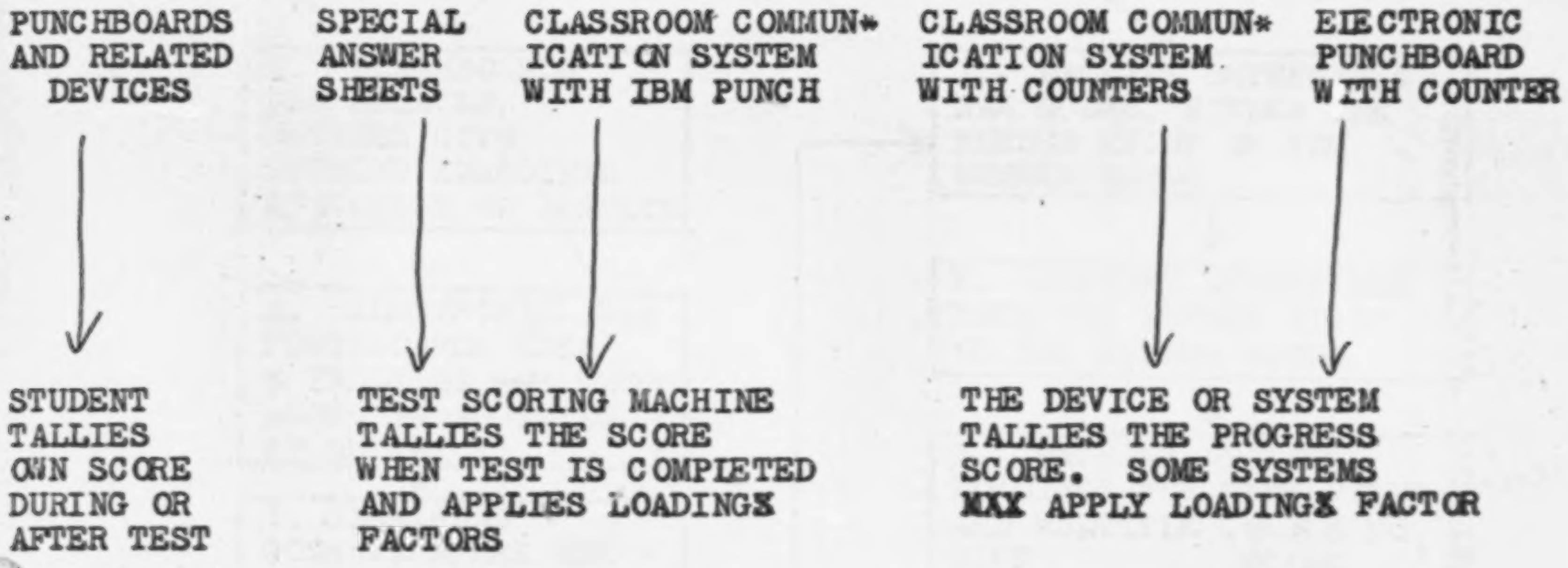
blank or pre-punched IBM type answer cards in a special holder. The Info-Tron unit has a stack of identical pre-punched IBM cards beneath the answer card so that the ball point or stylus will dig deeply when the choice is correct. The Instrument Research unit has a series of interchangeable metal strips to arrange the answer pattern. It uses pre-~~punched~~ cut answer cards (as used with the Burgess test scoring machine) to facilitate checking and item analysis. The General Atronics "TAG" (373) is a punchboard with a pre-punched answer plate. It has a large and amply spaced answer sheet, an advantage for younger students, along with space for some written answers on the same sheet. Yet another self-scoring arrangement can be attributed to A-Alpha (372) where a strip of paper covers the answers on the question and the unsharpened end of a pencil is used to punch out a hole. Correct answers are distinguised by a strip of color or printing visible through the punch-hole.

With some electronic punchboards, the student is required to answer each question in sequence, and the number of right and/or wrong ~~xxxxxxxxx~~ choices ~~are~~ is tallied automatically. ~~These~~ The instrument can be set up so that the student does not have immediate knowledge or results - the testing mode - or so that the student must make further responses until he finds the correct answer - the teaching mode. Since the machine ~~keeps~~ tallies the score and is cheatproof, the teacher has only to read the counters to determine the level of proficiency of the student. Such devices are made by Astra (4.12) and HRB Singer (4.13). The Astra machine has a time clock and error counter, and allows ~~only~~ ten questions per 8½X11 card. It is primarily designed as a teaching machine, ~~and~~ The Singer unit has both teaching and ~~testi~~ testing modes, ~~and~~ and can accommodate up to 210 answers per page. ~~if required.~~ ~~and the~~ ~~a~~ A variety of answer patterns and answer sheets ~~are~~ is available. It should be noted that a mechanical card sorter such as the NAK (4.6a) serves a similar function. The so called "arithmetic trainers" are very ~~xxxxxxxx~~ similar in principle to the electronic punchboards, having pre-set answer patterns, but because they are used for teaching rather than testing, they will be considered in the next chapter.

## C. 1963-1970: A LOOK INTO THE FUTURE

Test scoring machines, group response systems, and individual response units are part of a comparatively new trend. The next ten years will see the development of additional methods and devices, and in widespread introduction of them at the school level. Potentially the test scoring machine is a time saver and gives more accurate results than manual scoring. The group response systems will probably be introduced as teaching rather than testing machines. The ease with which they can receive answer codes on filmstrips or television programs will cause their widespread use in conjunction with mass media as well as in classroom teaching. The individual response units will undoubtedly be promoted as teaching machines, but their testing capability should not be overlooked. Indeed, teaching machines are simply a means of integrating teaching and testing, as shown in the chapter which follows.

# TESTING METHODS AND TEST SCORING DEVICES



PUNCHBOARDS AND RELATED DEVICES

SPECIAL ANSWER SHEETS

CLASSROOM COMMUN* ICATION SYSTEM WITH IBM PUNCH

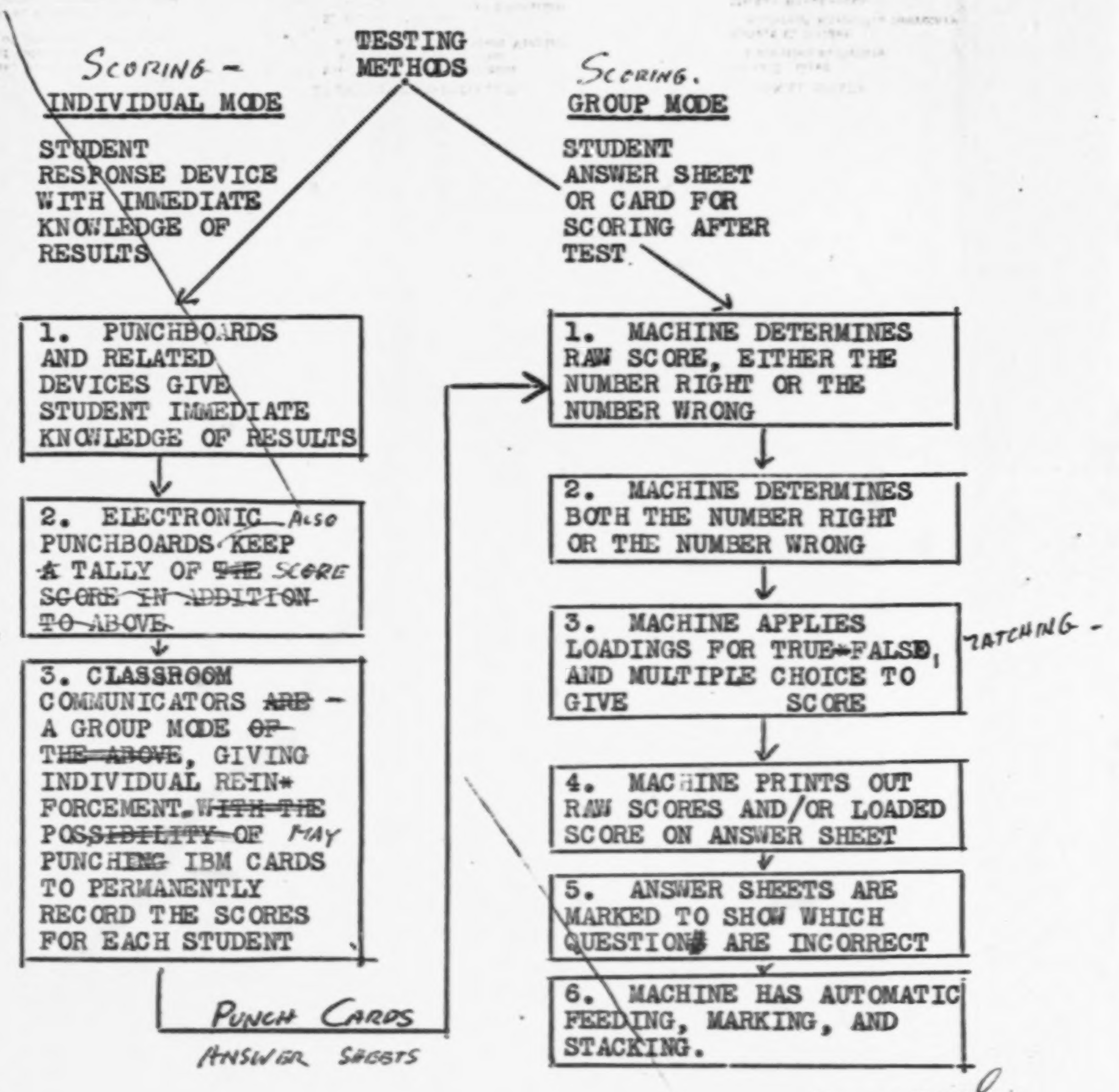
CLASSROOM COMMUN* ICATION SYSTEM WITH COUNTERS

ELECTRONIC PUNCHBOARD WITH COUNTER

STUDENT TALLIES OWN SCORE DURING OR AFTER TEST

TEST SCORING MACHINE TALLIES THE SCORE WHEN TEST IS COMPLETED AND APPLIES LOADINGX FACTORS

THE DEVICE OR SYSTEM TALLIES THE PROGRESS SCORE. SOME SYSTEMS MXX APPLY LOADINGX FACTOR



TESTING METHODS

Scoring -
INDIVIDUAL MODE

STUDENT RESPONSE DEVICE WITH IMMEDIATE KNOWLEDGE OF RESULTS

1. PUNCHBOARDS AND RELATED DEVICES GIVE STUDENT IMMEDIATE KNOWLEDGE OF RESULTS

2. ELECTRONIC ALSO PUNCHBOARDS KEEP ~~A~~ TALLY OF ~~THE~~ SCORE ~~SCORE IN ADDITION TO ABOVE~~

3. CLASSROOM COMMUNICATORS ~~ARE~~ - A GROUP MODE ~~OF THE ABOVE~~, GIVING INDIVIDUAL RE-IN-FORCEMENT. ~~WITH THE POSSIBILITY OF~~ MAY PUNCH~~ING~~ IBM CARDS TO PERMANENTLY RECORD THE SCORES FOR EACH STUDENT

PUNCH CARDS

ANSWER SHEETS

Scoring.
GROUP MODE

STUDENT ANSWER SHEET OR CARD FOR SCORING AFTER TEST

1. MACHINE DETERMINES RAW SCORE, EITHER THE NUMBER RIGHT OR THE NUMBER WRONG

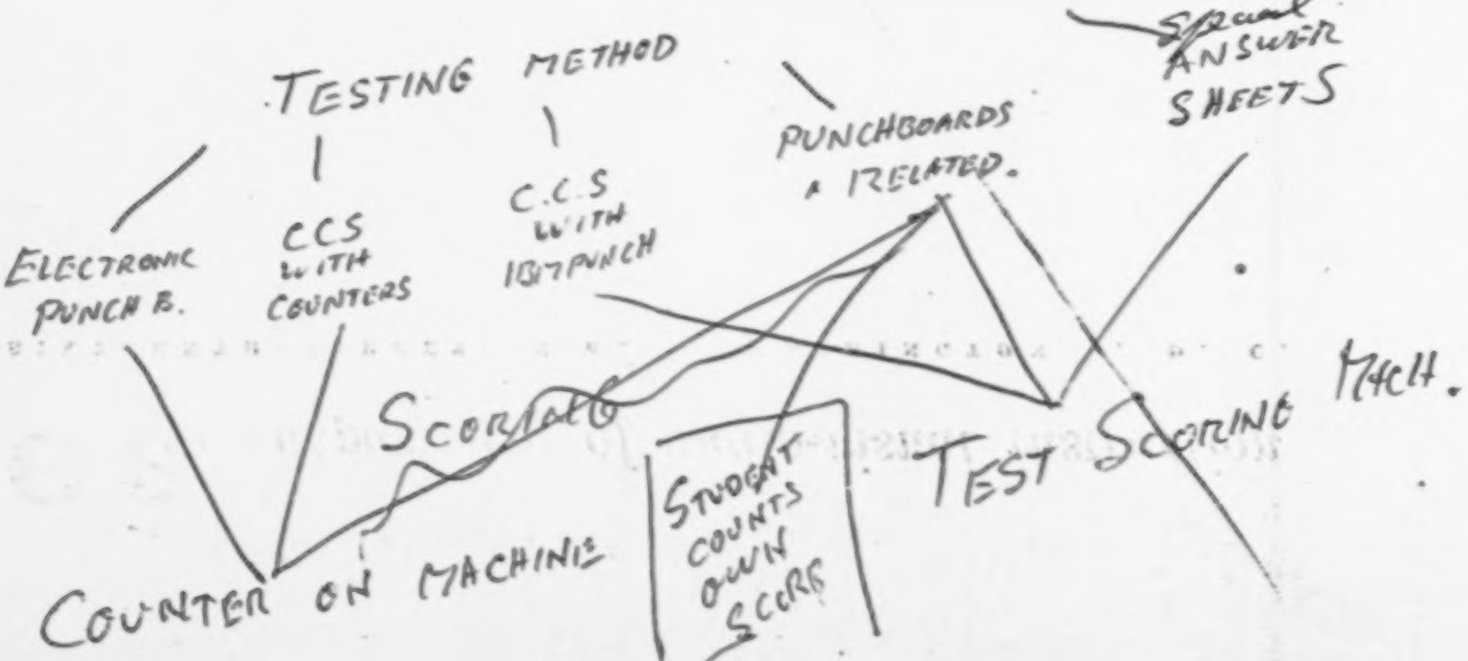
2. MACHINE DETERMINES BOTH THE NUMBER RIGHT OR THE NUMBER WRONG

3. MACHINE APPLIES LOADINGS FOR TRUE-FALSE, MATCHING - AND MULTIPLE CHOICE TO GIVE SCORE

4. MACHINE PRINTS OUT RAW SCORES AND/OR LOADED SCORE ON ANSWER SHEET

5. ANSWER SHEETS ARE MARKED TO SHOW WHICH QUESTIONS ARE INCORRECT

6. MACHINE HAS AUTOMATIC FEEDING, MARKING, AND STACKING.


Special ANSWER SHEETS
TESTING METHOD
ELECTRONIC PUNCH B.
CCS WITH COUNTERS
C.C.S WITH IBM PUNCH
PUNCHBOARDS & RELATED.
SCORING
TEST SCORING MACH.
STUDENT COUNTS OWN SCORE
COUNTER ON MACHINE

# TEST SCORING DEVICES

Operating principles - punch hole (mechanical), graphite (conductor)
(photo-electric)

1. Marking devices

marks correct answers
marks incorrect answers

2. Marking and counting

marks correct answers - counts correct answers
counts incorrect answers
marks incorrect answers - counts correct answers
counts incorrect answers
marks incorrect answers - counts both correct and incorrect answers

3. Automatic Printout of Score

printout of direct score

4. Automatic computation of loadings for multiple choice
5. Automated vs. hand loading machines

Test Scoring Devices with immediate knowledge of results

pull tab
scrape off
punchboard
electronic punchboard

Relation of test scoring devices to Teaching Machines

## TEST SCORING DEVICES

✓A-Alpha Pattern & Mfg. Co
3523 E. 4th St
Los Angeles 33, Calif.

Astra Corp
19 Burton Ave
Norwich, Conn

✓Burgess Cellulose Co.
P.O. Box 560,
Freeport, Ill.

Devereaux Teaching Aids
Box 717, Devon, Pa.

✓Electro Networks, Inc.
Educational Products Division
Maple Street, Caledonia, New York

General Atronics Corp
One Bala Ave
Bala-Cynwyd, Pa

Educational Specialties C
Murray, Iow

✓Electronics for Education, Inc.
10582 Metropolitan Ave.
Kensington, Md.

✓Infotron Inc
P.O. Box 10745
St. Petersburgh 33, Fla.

Jantzen Electronics
Mfg. Inc.
2285 University Ave
St. Paul 14, Minn.

Gerald J. Jensen
1267 Wensley Ave.
El Centro, Calif.

Instrument Research

HRB-Singer, Inc.
Science Park,
P.O. Box 60
State College, Pa.

✓International Business Machines Corp
590 Madison Ave, New York 22, N.Y.

Larsen Teaching Machines
Box 454 Petaluma, Calif.

✓SERCO
722 South Portland Street
Seattle 4, Wash.

✓Management Research Assoc
185 N. Wabash
Chicago 1, Ill

NAK Inc
Santa Barbara Airport,
Goleta, Calif

Renner Inc
1530 Lombard St
Philadelphia 46, Pa

✓Van Valkenburgh,
Nooger, & Neville, Inc
15 Maiden La
New York 38, N.Y.

# VIII. PROGRAMED ~~LEARNING~~ INSTRUCTION AND TEACHING MACHINES

## A. INTRODUCTION

A Program is a carefully organized and pre-tested unit of instruction which breaks down the information to be learned into small sequential steps. ~~designed to accomp[illegible] learning objectives~~. At each step or "frame" the student must actively respond~~, either~~ by writing in an answer or pushing a button. ~~[illegible]~~ Programed ~~learning~~ instruction ~~is not a passive experience,~~ ~~but~~ requires continual active involvement on the part of the student. Each response is rewarded by immediate knowledge of results so that wrong answers are corrected, and right answers ~~are~~ reinforced. The most important outcome of programed learning is that instruction ~~can be~~ is individualized, ~~so~~ ~~that~~ allowing each student ~~can~~ to work at his own rate. This self pacing feature permits higher achievement for the fast learner while giving the slower student time to master the material. Since programs are pre-tested and validated to ~~[illegible]~~ a pre-determined level of performance with some designated group, ~~of students, then other~~ a comparable level of achievement should result with other similar groups of students. ~~should have little trouble learning~~ ~~[illegible] much progress, and achieve a similar level of [illegible]~~ ~~[illegible]~~ ~~comparable~~ ~~achievement.~~

A teaching machine is not essential for presenting the program, but provides increased control over the learner, since it can prevent access to the answer until the response is made. Any machine without this controlling feature is little better than a mechanical page turner. Machines prove advantageous in a classroom situation, since little direct supervision is required. The machine may also be a motivating factor, particularly with younger children, in addition to performing mechanical functions, such as scoring, which reduce human time and effort. It should be emphasized that although this chapter is devoted to the hardware aspects of programed learning, the quality of learning which results is due almost entirely to the program. The equipment is simply a convenient means of storing and presenting the information, and of overcoming the logistic problems of handling programs and the associated response data. In many instances programs in book form teach just as well as a machine.

## 1. Purpose

Programed learning is a means of increasing the efficiency of instruction through individual tutoring and the application of

~~PRESSEY + DALE~~

Fig. 38 Sidney L. Pressey shows his early teaching machine to Edgar Dale.

psychological principles known to assist learning. Interaction between the student and the material to be learned is achieved through a unique method of organizing and presenting the content. Problem areas are anticipated by pre-testing and rewriting until the desired learning is achieved. Since the more common learning problems are anticipated by the ~~overcome through~~ program~~ing~~, and since ~~especially where~~ machines ~~are used to~~ minimize supervision and other tasks not essential to learning, the classroom teacher is set ~~set~~ free to help students with their individual problems. See previous page *

## 2. History,

Devices related to the teaching machine date back over 100 years, but programed instruction ~~learning~~ as such began with the work of Sidney L. Pressey at Ohio State University in the early 1920's. Pressey designed a machine for automatic scoring of multiple choice tests, and found that immediate knowledge of results for the student promoted learning, so that the test became in fact a teaching tool. Pressey's work did not gain importance until ~~till after~~ 1954, when B. F. Skinner published a paper describing his own experiments in the use of teaching machines. This led to intensified research by a number of groups, aided by military contracts, and later by funds through the National Defense and Education Act. By 1960 programed ~~learning~~ instruction was no longer a curiosity of the psychology lab, but had entered the field testing stage. Its potential value in ~~education~~ the classroom was already evident so that numerous companies ~~began~~ set up to write programs and design teaching machines.

## B. TRENDS AND DEVELOPMENTS SINCE 1955

For all practical purposes it may be said that the technology of programe~~d~~ing ~~learning~~ has come into existence since 1955. The host of experimental programs and devices are now giving way to units especially designed for use in schools and colleges, business and industry, military training, and for home consumption ~~either~~ as educational toys, or ~~as educational~~ supplements to ~~well-known brands of~~ encyclopedias. The programs and devices vary enormously as to form and format, but all have certain functional elements in common which reflect the particular philosophy adopted by the programer.

### 1. Philosophies of Programing.

~~Since~~ Programed learning has been largely developed by experimental psychologists and reflects current psychological theories such as behaviorism and gestaltism. The more extreme orientations are now being modified by new ideas not associated with a particular school and the results of recent research findings. Five major contributions to programing philosophy are attributed to Skinner, Pressey, Crowder, Gilbert, and the Center for Programed Instruction.

### a Skinner: Linear Programs with Constructed Response.

Linear programing requires each student to complete every item of the program. Skinner emphasizes the need to break down the information into very small steps so that even the less able students can proceed easily through the program with a minimum of errors. Skinnerian programs are usually validated to obtain about 90% correct responses for 90% of student population. Responses are written or constructed since this requires recall rather than recognition, and recall tests a greater depth of learning. A low error rate is ensured by prompting or cueing, and gradual weaning or fading of these cues promotes learning. ~~strict~~ ~~allows the student to come up with the correct answer without prompting.~~ ~~This means that learning has taken place.~~

### b. Pressey: Linear Program with Multiple Choice Response.

Pressey places less emphasis on breaking down the information and uses multiple choice responses. He does not consider errors important since they are not reinforced, and the student cannot proceed until the right answer is discovered. Since only the correct answer is rewarded then, according to the Law of Recency, whose? this is the response which is learned. The multiple choice response mode has been criticised ~~since~~ because? it uses recognition rather than recall to identify the answer, but research has so far failed to show Pressey type programs to be inferior to Skinnerian methods.

### C. Crowder: Branching Program with Multiple Choice Response.

Crowder ~~uses~~ employs still larger items with multiple choice responses, and utilizes the errors to ~~diagnose~~ determine ~~those~~ areas ~~which require~~ needing further instruction. In this way, the program adapts to the peculiar needs of each student. Where the learner gains competence easily he is given an express route through the program, while ~~in~~ areas ~~he finds more~~ of difficulty ~~he~~ are taught in greater detail. ~~receives additional instruction to bring him up to a predetermined~~

Although branching programs can be presented in book form, machine presentation is almost mandatory for the more complex branching programs.

d. Gilbert: The Mathetics Technique. The preceding philosophies have placed emphasis on item size, error rate, linear or branching format, using constructed or multiple choice response. Gilbert utilizes all these techniques, where they seem appropriate. His Mathetics approach ~~places more emphasis on the terminal behavior or goal. So that the ultimate goal will be kept paramount, he begins~~ it begins with the terminal behavior and works backward, filling in each sequential step one by one. In this kind of program the goal is always clear since it is introduced at the beginning rather than at the end of a sequence.

e. Center for Programed Instruction. Linear programs could be made more efficient if a higher error rate could be tolerated. The Center for Programed Instruction have developed a format with branches at the terminal frame of each linear sequence to help the less able student. It would seem that this technique incorporates the best features of the earlier programing philosophies. The general trend in programing today is toward selecting techniques from the various philosophies according to the demands of the subject matter. This research and experience are modifying the more extreme viewpoints, and allowing programs more variety in style.

## 2 The Problems of Hardware. 8.

type

Although much of the initial research in programed learning was done with the aid of teaching machines, there has always been a segment of the field opposed to the use of hardware, and this is due at least in part to the limitations imposed on the programer by some of the early machines. A number of book type formats have been developed to simulate machine presentation, some of which are quite ingenious. Programed and "scrambled" texts, masking devices and other "non machine" forms of presentation will be briefly discussed before proceeding to the more complex hardware.

a Text Formats. Special book formats have been devised to prevent accidental reading of the answers before the response is made. In the Programed Text, linear programs are presented with succeeding frames one beneath the other or on consecutive pages. ~~and the answer appears before the new frame on the following page.~~ Each page ~~is~~ divided ~~into several strips, and the program is read by~~ following ~~the top~~ right hand strip through the book, then the second strip, and so on. When all strips of the right hand pages have been read, the book ~~is turned~~ upside down ~~so that the second half of the text can~~ is ~~be~~ read ~~on the~~ as right ~~hand pages~~ also. Figs shows ? a pages from a typical programed text. ~~This format has been adopted by Harcourt Brace ( ) McGraw Hill ( ), and others.~~

The Scrambled Text is a method of presenting branching programs. ~~In this instance~~ There usually is only one frame ~~on each page, which consists~~ to a page, consisting of a paragraph of information and a test. Each of the possible answers refers the student to a page elsewhere in the book, so that the student has no way of knowing ~~till~~ until he turns to that page whether or not his answer ~~was~~ is correct. If the choice was wrong ~~incorrect~~, the answer page explains why, gives the student some additional tutoring, and sends him back to reconsider the ~~previous~~ question.

Ron To
G.f.

(381) COLORTONE

(382) EBF "TEMAC" USING "LEARN EASE" FOLDER NATIONAL BLANK BOOK CO,

(383) INSTRUCTIVE DEVICES

(384) PARTNER :

(385) U.S. INDUSTRIES

If his next choice is right, it is reinforced, briefly reviewed, then the next item ~~to be learned~~ is presented. Some typical pages from a scrambled text are shown in Fig. . This format is presently used by the ~~American~~ Institute of Research ~~( —) and Doubleday.~~( )

b. Masking Devices. Linear programs are commonly presented with consecutive frames one beneath the other, ~~so that some kind of~~ and a mask is ~~needed~~ often used to prevent accidental reading of the answer before the response is made. Various page layouts have been used, with the answer at the left, right, or underneath, ~~and with~~ the mask may be full width across the page, or covering only the answer column. There is always a possibility of some students "peeking" at the answer, but so long as the program is actually read (rather than just copying ~~in~~ the answers), there seems to be little loss of effectiveness. Numerous programing companies are publishing their materials for use with masks which vary from a piece of card to special ~~books~~ folders manufactured by the National Blank Book Company (382).

For multiple choice answers, the problem of cheating has been overcome by? using punchboards, pull-tab boards, erasible silver overlays and sliding masks. The first two are separate from the program, the third may be separate or integral, while the latter is like a machine with the program inside. Punchboards, pull-tabs and erasible overlays have already been discussed in the chapter on testing, and for teaching machine applications they need only a matching answer code for the program being used.. The erasible overlay can also be printed directly on the program to "mask" the answers, so that the sheet of paper simulates many of the functions of a machine, but with the disadvantage that the program is not re-usable. Two novel sliding mask devices for multiple choice answers have recently been introduced by Instructive Devices (383) and U. S. Industries (385). In either case the ~~program~~ slide will advance only if a correct answer has been selected.

c. Flash Cards. Separate cards with the stimulus material on one side and the correct response on the back have been used for many years in

DON
TO
PHOTO

(386) **EZ Sort Card**

(387) **EZ Sort Card Storage**

**Fig. 388 Cards were used to achieve a limited branching function for a recent experiment conducted at the University of California, Los Angeles by**

teaching, and are admirably suited to rote learning activities where cards answered incorrectly can be stacked separately, and this stack repeated over and over until all of the responses have been learned. It should be noted that flash cards may use constructed response, multiple choice answers, or matching techniques, and are admirably suited to learning simple tasks such as vocabulary.

EZ Sort (386)(387) ~~Ed-U-Cards~~ have a special form of card for multiple choice responses, where a set of holes along one edge allows the cards to be sorted with a needle or ~~stick~~ thin rod. The cards are handled in a stack, and answer selection is by putting the rod through the hole corresponding with the selected answer, which drops out the next card. (Scientific Prototypes once handled a card sorter which accomplished the same purpose.) Note that this method allows branching ~~Crowderian type programing,~~ since remedial information can be included in addition to reinforcement of the correct answers.

d. Teaching Machines. This name is almost a total misnomer for the device it describes, ~~and~~ The term "self-instructional devices" would be more accurate and acceptable. The existing machines use three response modes - ③ spoken (verbal) as in a language lab, ① constructed (usually written) as in the typical Skinnerian machines, and ② multiple choice, which would be P sserian if the program is linear, ~~and~~ Crowderian if the program is branching. + Since multiple choice responses can be written and constructed responses can be entered on a key punch or typed, a host of hybrid forms of response have come into existence, along with a wide variety of hardware. This hardware falls into two broadly defined categories - general purpose and special purpose teaching machines. The conventional Skinner~~ian~~ and Crowder~~ian~~ or Pressey~~ian~~ type ~~of~~ device can handle a wide range of subject matter~~, ranging~~ from Atomic Theory to home economics, and can therefore be regarded as a general purpose instrument. More complex instruments for specific applications ~~involving the use of computers~~ will be discussed later under the heading "special purpose teaching machines."

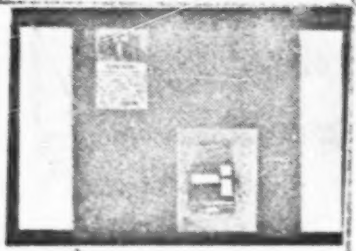
## 3. General Purpose Teaching Machines

Devices which can be used to teach a wide variety of subject matter are termed "general purpose teaching machines," while units which, can teach only one kind of subject matter, or these which involve large and expensive control mechanisms such as computers, are regarded as "special purpose teaching machines."

The general purpose machines are relatively inexpensive, and usually involve either written or push button response. The least expensive units use paper programs, which may come in the form of special books, paper sheets, rolls, fan-fold, discs, or cards. In a few instances plastic ~~film~~ may be substituted for paper, giving increased durability. Because paper programs are bulky, a number of manufacturers use film programs, which also allow~~s~~ ~~more~~ economic use of graphic devices and color. Some macnines incopporate motion pictures, or the dual ~~capacity for~~ facility of motion ~~or filmstrip presentation~~ ~~presenting~~ single frames as required.

a. Skinnerian Devices. These typically use a write-in response with a paper program enclosed in a box so that only one

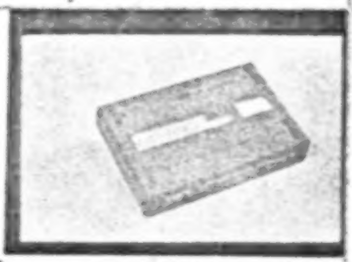
PAPER PROGRAM — WRITE IN ANSWER



(386) A-Z ALPHA

½

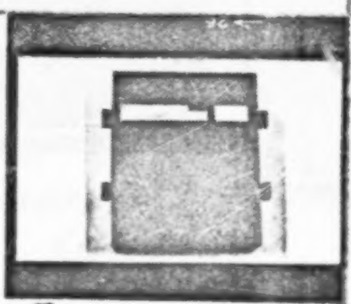
(387) AVTA



(388) CENCO

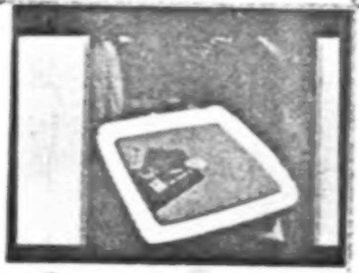
~~COMPTON ENCYCLOPEDIA~~

~~CONCORD CONTROL~~



(389) EDUCATIONAL AIDS

(390) ED-U-CARD



(391) FIELD

(392) GENERAL EDUC.

(393) GRAFLEX

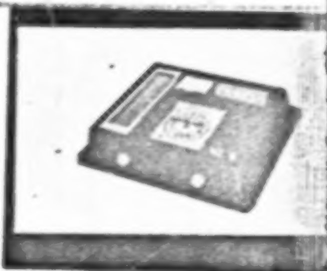
(394) GRAPHIC - ROLL

?

(395) HAMILTON

(396) HUNTER

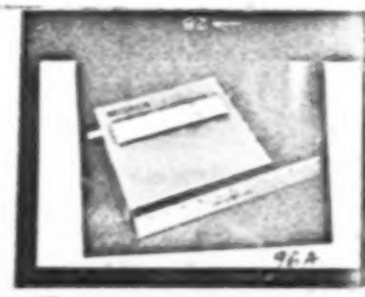
(397) MODERN TEACHIN
~~AIDS~~
ASSOCIATES



(398) NATIONAL COMMUN
ICATION LABS

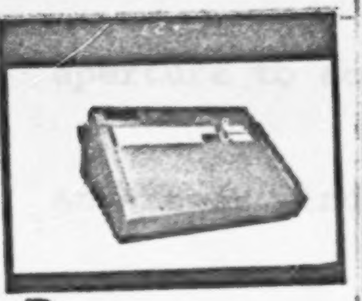
~~DON TO COPY FROM SLIDE.~~

~~(399) NATIONAL EDUC. SYSTEMS~~

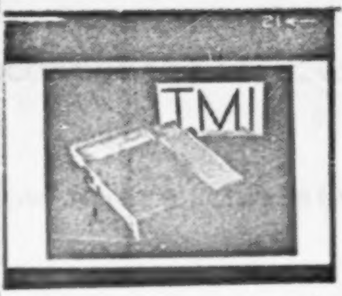


(400)
PROGRAMMED
TEACHING AIDS

PAPER PROGRAM— WRITE IN ANSWER

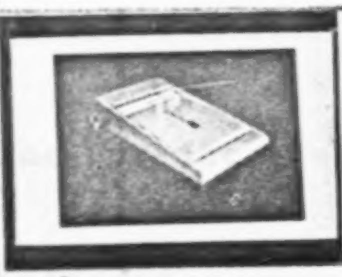


(401) PROGRAMMED TEACHING AIDS



TEACHING MACHINES INC (405)

(402) RHEEM



UNIVERSAL (406)

(403) RHEEM

(404) STATEN

frame is visible at a time. Many machines have an adjustable aperture to accommodate different program formats. There is also an answer window where the student may write his answer directly on the program or on a separate answer tape. When the program is wound on, the student's response is covered by a transparent window and the correct answer is disclosed. By comparing the response with the correct answer, errors are corrected and correct answers are reinforced.

(1). Paper programs and write in answers are used in devices by A-Alpha (386), AVTA (387), CENCO (388), Educational Aids (389), Ed-U-Card (390), Field (391), General Education (392), Graflex (393), Graphic-Roll (394), Hamilton (395), Hunter (396), Modern Teaching Associates (397), National Communication Labs (398)*~~,~~ ~~National Educational Systems (399)~~*, Programed Teaching Aids (400 & 401), Rheem (402 & 403), Staten (404), Teaching Machines Inc. (405), and Universal Electronics (406). Companies marked by an asterisk (*) do not yet have devices for sale.* ~~National Educational Systems (399) have adopted plastic rolls, and~~ National Communications Labs (398) 459 a system of plastic envelopes, to increase the durability of their programs for young children.

FILM PROG – WRITE IN ANSWER

(417) Du Kane

(410) RECORDAK

~~CONCORD CONTROL~~

(411) RECORDAK

(408) GRAFLEX

(411a) Viewlex
find in pic file

(409) MAST

Table 19 plots features such as program format, separate answer tapes, etc. for this group of devices.

②. A. A. Lumsdaine predicts that most programs will eventually be on film, since film programs require less storage space than paper. This in turn requires some kind of magnifier or viewer for presentation. The simplest approach is a magnifier with daylight illumination as in the Graflex (408), which corresponds to a masking device using film instead of paper programs. The more complex machines are mostly variants of filmstrip and microfilm viewers. DuKane (407) and Viewlex (411a) have added answer tapes to their conventional filmstrip viewing devices so that they serve the dual role of viewers and teaching machines. Recordak (410 & 411) has devised a special kind of envelope to hold a series of strips of 16mm microfilm for presentation by a simple viewer with a write-in response unit. Mast (409) has a unit with a flip-over cartridge for 35mm filmstrips, and an automated answer tape.

~~unit using filmstrips or cards with both automated answer tape and push-button response.~~ The various features of the ~~used with~~ film ~~prog~~ devices for write-in answers ~~is~~ are summarized in Table . ?

*b.* Presserian Devices. Pressey advocates multiple-choice answers as in testing, so that the essential difference between these and the previous machines is the mode of response. In this instance the device discriminates whether or not the student responded correctly, and usually prevents the student from continuing until the correct response is discovered. Just as the Pressey type teaching machine developed from methods of multiple-choice testing, many of the testing devices can be used for programed learning where provision exists for immediate knowledge of results. All of the self-~~testing~~ scoring devices mentioned in the chapter on Testing, where used in conjunction with programed materials (~~which differs from tests in their step-by-step organization~~ as well ~~as their intent)~~ become, in effect, teaching machines. Hence punchboards, pull tab, and erasible overlay devices may be used for teaching as well as testing purposes

In Testing has pictures

~~Table summarizes these devices.~~

# ELECTRONIC PUNCHBOARDS AND ARITHMETIC MACHINES

(412) **Astra**

(418) **Jantzen**

(413) **Comparator**

(414) **Devereaux**

(415) **Devereaux**

(416) **Educational Specialties**

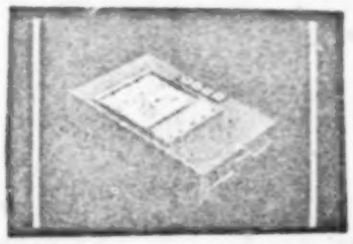
(417) **HRB Singer**

(1). Electronic punchboards score the student's response when he makes his choice with an electric "pencil." ~~Thisxpencilxis~~ The pencil completes an electrical circuit within the machine. The answer pattern may be permanently wired with answer sheets of different format to achieve a variety of answer patterns, or the answer might be code-punched on the top of each question card.. The former is used in HRB Singer's test scoring device (417); the latter in the Astra teaching machine. (412) Arithmetic trainers are yet another variety of electronic punchboard, and these include models by Comparator (413), Devereaux (414), (415) Educational Specialties (416), & Jantzen (418), ~~and Smith Harrison ( )~~.

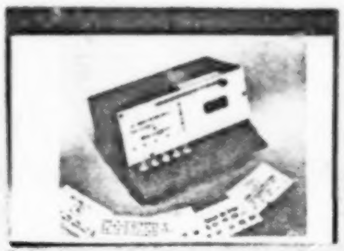
(2). Card sorters such as the NAK (418a) are useful for arithmetic and numerical problems

## PAPER PROGRAM * PUSH BUTTON ANSWER TEACHING MACHINE

(419) **General Atronics**

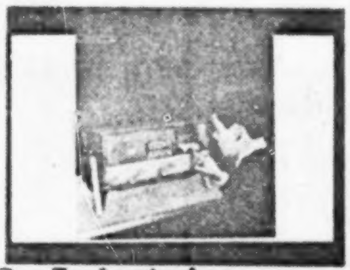


(420) **Honor**



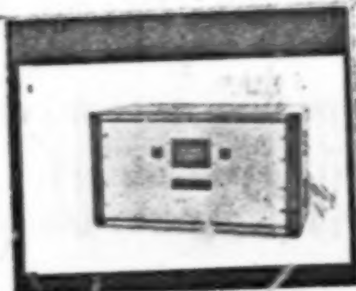
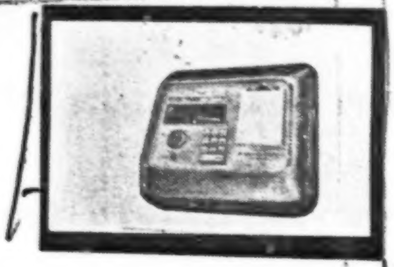
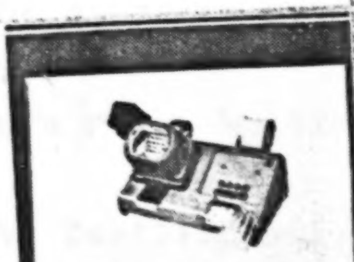
(421) **Publishers Co**

(422) **Rheem**



(423) **U.S. Industries**

(3). Pressey type teaching machines using paper programs are manufactured by General Atronics (419), Honor (420), Publishers Co., Inc. (421), Rheem Califone (422), and U.S. Industries (423). The Atronic device uses a book format in which pushing the correct answer button causes the page to drop down and reveal the next question. Honor uses a paper roll which is battery powered, and this machine has a limited branching capability. Publishers Co., Inc. accomplish a similar function using cards, with the added reinforcement of a bell and a green light. The Rheem unit is intended for pre-verbal learning, and advances automatically when the correct answer window is pressed. This device also has provision for item analysis. The U.S. Industries device is for paired associates training and accepts teacher prepared programs.

| ~~Pus~~ Film Prog - | Push Button Ans. |
|---|---|
| <br>Education Eng.<br>(424) | <br>Teaching Machines Inc<br>(428) |
| <br>International Electronic Engineers<br>(425) | <br>Teaching Machines Inc<br>(429) |
| <br>Multimatics<br>(426) | ~~Training systems Inc.~~ |
| <br>Standard<br>(427) | ~~Teaching Machines Inc~~ |

(4). Pressey type machines using film programs are available from Standard (427) and Teaching Machines Inc (428) (429), while Training Systems has a prototype unit. Standard has redesigned ~~their~~ its 35mm filmstrip viewer to include push-button response, with automated answer tape and film advance when the correct answer is selected. Teaching Machines Inc has developed a preverbal machine which uses 8mm film in a simple cartridge. Training Systems* ~~have devised a novel method of~~ uses ~~using~~ the response buttons to cover the appropriate responses projected on the screen, which also facilitates the use of branching programs.

(5). If we define a Pressey type machine as being any device with push button response that does not involve branching, then several additional devices must be added to this category. Education Engineering (424) has a device which uses matching rather than multiple-choice answers, and refers the student back to the stimulus material if he fails to get three correct answers in a row. MultiMatics (426) uses a ten-key alpha-numeric keyboard to facilitate multiple-choice or constructed responses. Programs are on plastic discs, and the machine has teaching,

* NOT IN PRODUCTION

TEACHING MACHINES WITH SOUND

(430) AVTA

(436) Lectron

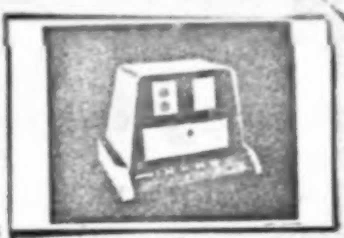
(437) Lectron

Don – to check

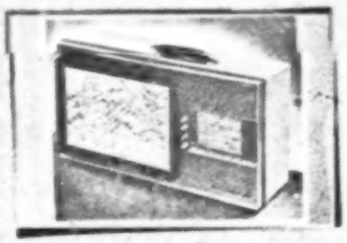
(431) at DuKane Aids

(432) Educational Aids

(438) Visual Programing

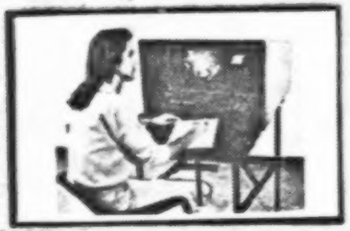


(433) Gilfillan



(439) Visutronics

(434) Hughes



(440) Williams

(435) Instructive Devices

432a FMC Inc

testing, and timed modes of operation and can be joined with other machines for competitive operation.

The Wychoff Film Tutor manufactured by Teaching Machines Inc (429) has a typewriter keyboard which allows a full range of multiple choice, constructed, and matching responses. It is especially valuable for typing + spelling, ~~and related skills~~ in addition to general purpose operation. Hughes (434), Lectron (436), and Visual Programing (438) have a sound capability on their Pressey type machines, so that audio-visual presentation can be used. The Hughes unit ~~al~~so has an automated answer tape as does the DuKane sound filmstrip viewer (431) when adapted for teaching machine operation. Visual programing (438) has built ~~their~~ its device integral with the desk unit, a trend usually reserved for larger and more complex machines, while Hughes (434) has designed an additional device to assist in the development of programs, which allows recording of master tracks, ? cueing of stop and start, and ~~of~~ programing the appropriate answer for each question.

Williams (440) has engineered a means of cueing a sound motion picture projector to stop on a given frame ~~and~~

American Teaching
(441)

U.S. Industries
(445)

(442) Cinescopes

U.S. Industries
(446)

Minneapolis
(443) Honeywell

Honor

See Earlier

(444)
Thompson
Ramo
Wooldridge

Visotronic

See Earlier

for the presentation of a multiple choice problem. The response is recorded on an answer tape, and only a correct response will allow the student to continue. Visutronics (439) has developed a dual cartridge using 8mm film with ¼" magnetic tape for sound, which also provides pulses to ~~which~~ advance the film one frame at a time or as a motion picture to synchronize with the sound. This combines the advantages of both still and motion picture projection in~~to~~ a single unit. ~~It also has an answer tape to record the responses.~~ ?

C. **Crowderian Devices and Branching**. Although simple branching programs can be presented in scrambled text form, these are limited in size and flexibility. Also the time + effort expended ~~and much time is consumed~~ in looking for page numbers~~, a process which~~ contributes nothing to the learning process. Another approach is the sorting of cards, either manually as with the EZ-Sort System (586) or using a simple machine. For those who can afford them, the machine is to be preferred for use with branching programs. The core of most of these devices is a random access projector using, in most instances, 35mm film. The classical Crowder machines are those developed by U.S. Industries, the AutoTutor I (445) and the AutoTutor II (446). The former is a console unit with elaborate branching capabilities~~, with~~ and provision for both motion picture and frame-by-frame operation. Both ~~the~~ response time and the answer sequence are recorded, giving invaluable research data in addition to a check on the student's progress. The AutoTutor II is a desk unit of much simpler design having less flexibility ~~in~~ branching, and record~~s~~ing only a total score for each student.

American Teaching Systems (441) has a sound filmstrip unit with a limited branching capability - one remedial frame for each wrong response, then re-routing the student back to the stimulus frame to choose another answer. Minneapolis Honeywell (443) has a sound unit using 16mm film with ~~which has~~ a full branching capability. Instead of the multiplicity of buttons of the Crowder machine, the branching logic is stored by a grid format recorded on each frame of film. The unit developed by Chapman for Thompson Thompson Ramo Wooldridge*(444) use~~d~~s ~~yet a third approach by installing~~ computer logic to control the branching, ~~and this method also~~ The computer allows weighing of not only the last response, but of several previous responses to decide which route the student should follow.

Instances where a computer is used to monitor the progress of more than one student, or where the computer itself is used to store the programed material will be discussed in later sections, since these are essentially research tools at this point.

d. Verbal Response. There has been much discussion as to whether verbal responses to programed material are as valuable or as valid as written or push button responses. Several of the machines already discussed have this capability in addition to the regular response modes, notably devices by American Teaching Systems (441), DuKane (431), Gilfillan (433), Hughes (434), Lectron (436 & 437), Minneapolis Honeywell (443), Visutronics (439), and Visual Programing Inc. (438). The AUTA (430), Modern Teaching Associates (397), and Teaching Machines Inc. (428) devices have provision for interlocking with a tape recorder for audio-visual type operation. Certainly the inclusion of this additional response mode does not disqualify any of these devices for their title of teaching machines, but the question remains, does a machine with only a sound recording capability constitute a teaching machine?

If spoken responses were acceptable, a language lab would be considered a teaching machine. The authors suggest that by adding two additional qualifications, spoken responses would be as valid as any other response mode. In a language lab the stimulus material is presented primarily as spoken language. Where methods of presentation are included whether printed or graphic and the information organized according to the principles of programed instruction, then a device using (only) spoken responses would qualify as a teaching machine. A whole group of individual sound viewers could thus be considered as teaching machines, primarily those using magnetic tape for sound, and with the facility for recording the student without erasing the master track. Table tabulates the individual sound viewers which already have this facility, or which could easily be adapted. (See P. ).

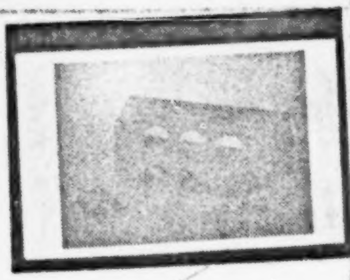
e. Group Response Systems. These have already been mentioned in the chapter on Testing. The provision of immediate knowledge in of results allows these systems to be used as a kind of teaching machine. They are not teaching machines in the classical sense, since the student cannot proceed at ;his own rate, but there are some advantages inherent in this method.

A sport description of the system in operation will help make these apparent:

The teacher begins the lesson with a short review, and has questions programed into the presentation to evaluate the present knowledge of the students. The questions are multiple choice, and the student presses the appropriate key on his desk unit. A red or green light informs the student whether he is right or wrong, ~~and~~ but the light ~~is so~~ being ~~placed that it~~ is not visible to ~~neighboring~~ students. nearby.

~~Each~~ the response is ~~also~~ recorded on the teacher's console so that the teacher ~~knows when the response is made, and how many students scored a correct answer.~~ has a tally for each student and for the class as a whole ~~In the event of a~~ A poor class response~~,~~ to any question indicates the need for further instruction. ~~is evident~~. If the class scores well, the teacher proceeds to the next point.

Next comes a film or filmstrip which is presented in segments, with continual testing and evaluation of the learning which is taking place. In this way problem areas ~~can be~~ are discovered at the time of teaching and can be immediately corrected. by the teacher.

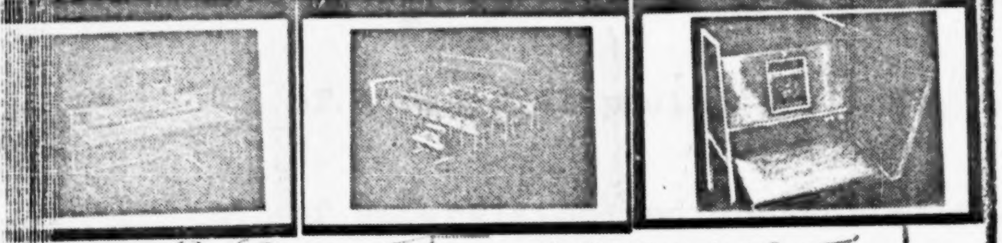


(447) AIRCRAFT ARMAMENTS

?
447a

(451) KUNINS

(452) LECTRON

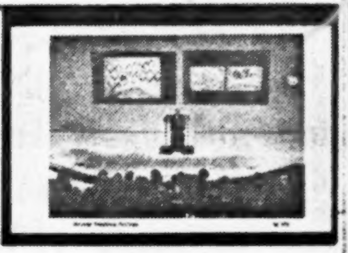


(448) DIAMOND ELECTRONICS

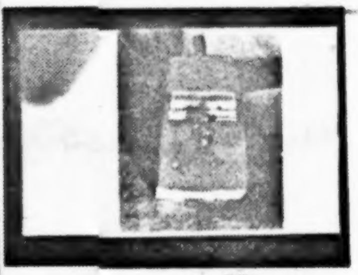
?
RESPONSE UNIT

STAPLES HOFFMAN

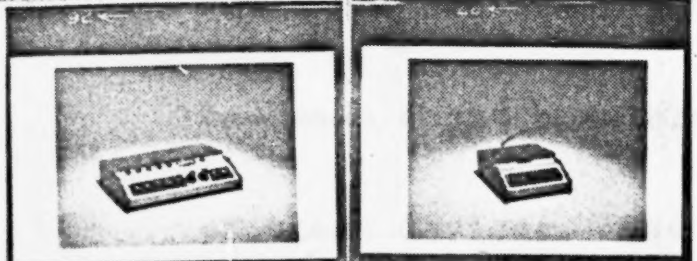
(449) EDEX ~~(EEC)~~



(453) TELEPROMPTER



?



(450) EDOC Electronic TEACHING LABS

Group response devices may be used by the teacher directly, or in conjunction with audio-visual media such as tape recordings, filmstrips, slides, motion pictures, television, or any combination of these media. In all instances except broadcast television the teacher can stop to clarify areas of difficulty before continuing with the program. Hence, although the advantages of individual pacing are lost, the teacher has an added degree of supervision and control over the learning process due to the contimual evaluation of what is ~~being~~ learned. ~~Many of these devices allow scores to be kept for each individual student.~~

Group response systems have been developed by Aircraft Armaments (447), Diamond Electronics (448), Corrigan for Electron ~~Educational~~ Teaching Labs ~~[Corrigan]~~ (450), Edex (449), Kunins (451), Lectron (452), ~~Staples Hoppman ( ),~~ + Tutor Tape Laboratories ( ). ~~and~~ Teleprompter (453), Since a number of these systems are still in the development phases, an attempt to describe each in detail would not necessarily be accurate. ~~so~~ Some generalizations ~~will be drawn~~ about possible features will help in assessing ~~their features~~ these devices ~~which are already present on some of these devices~~. Each student has a separate response unit which is connected to the teacher's console at the fromt of the room. Student responses are reinforced by red or green lights.

~~A~~ Lights on the teacher's console ~~that~~ tell her when each student has responded, or even what response each student made. A meter indicates the percentage (or number) of students that responded correctly. Additional meters may indicate the number of students choosing other alternatives. Counters ~~may~~ keep the score for each individual student. It is possible to punch IBM cards to record responses for later processing. The correct answers can be ~~recorded~~ programmed on tape or film, or transmitted via television so that the teacher is given warning of the correct answer, and the students confirm their opinions by responding. Loaded scoring, the programing of several pieeds of equipment to operate simultaneously, and other capabilities can readily be included in such equipment.

## 4. Special Purpose Teaching Machines

The peculiar ability of the computer to rapidly process large volumes of data enables it to perform very detailed evaluations and make quite complex decisions. While a conventional teaching machine can make only simple mechanical decisions, a computer can be much more flexible and adaptive.

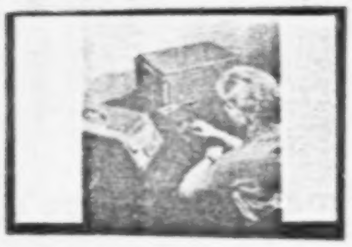


Fig. 45a Rheem-Pask Psychomotor Trainer.

Lessons on the IBM Key Punch (center) are presented on the display unit (left) controlled by the computer (right).

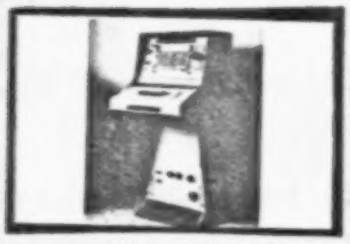


Fig. 45b Rheem Electronics Typewriter Trainer. Based on the Pask Key Punch trainer, it is ~~progr~~ programed to insure rapid progress and thorough learning.

By ~~adapting~~ modifying the program ~~more closely~~ to meet the needs of the individual learner, the computer is, potentially, the ultimate in teaching machines.

Pask's device for psychomotor learning illustrates the adaptive powers of the computer. This device is shown in Fig. 454. The program is internalized in the small computer on the left, and problems are displayed by the unit on the right. The task is to learn key punch training, and an IBM key punch is shown in the picture center. The initial problems are presented on the display patterned after the keyboard layout, and ~~later~~ more difficult problems are later presented on the simulated IBM card above. At first the problems are very simple, and the operator learns to follow a sequence of lights corresponding to the different key numbers. All different number combinations are learned, and in areas of difficulty the operator is given extra problems, or even dropped back to an earlier stage of the program to build up proficiency. In general, as the operator becomes faster and more proficient, the problems are presented more rapidly, and become more difficult. If the learner fatigues, the pace relaxes; and if the learner falls into error, the computer ~~drops back to~~ gives easier problems. ~~to rebuild the confidence and skill of the student.~~ This sympathetic and responsive mechanism makes for rapid and thorough learning, since the computer is always presenting the student with a challenge at a level he can master. A similar device for teaching typewriting is manufactured in the U.S. by Rheem Electronics. (45)

The flexibility and adaptive qualities of the computer can also be applied to intellectual learning and skills, ~~and~~ th~~is is~~ one of the most exciting areas of research at the present time. The high initial cost of the computer will probably be a deterrent to its adoption, but with leasing arrangements, and the increasing availability of second-hand computers at a reasonable price, a breakthrough in the cost structure seems possible. Also, since the computer can usually save its cost in the business office, and this same computer can simultaneously handle scheduling, teaching machines, and other kinds of activities, its introduction into schools may

may not be far removed

## ~~II~~ C. 1963-1970: A LOOK INTO THE FUTURE

The surge of innovation in the field of teaching machines and programed learning is now giving way to an era of steady growth. Its history parallels in some ways the development of books, in that the early programs were almost completely verbal, while later programs often incorporate pictures and graphic devices. As programs have become more visual, there has been a trend toward film programs which also reduce the bulk of programed material for more convenient storage. ~~However,~~ The initial cost of ~~the~~ film viewing units is a deterrrent to their adoption so that inexpensive Skinner type devices will probably be the mainstay of education for the next five or ten years. The development of audio-visual devices is also important since it opens up new possibilities in teaching and learning, but again it will be some time before school planning and school budgets can accommodate ~~such units~~ these. If ~~they~~ Teaching Machine are ~~gotten~~ acquired at the expense of teachers salaries and number of teaching personnel, they defeat their own purpose. ~~so~~ Other new sources of income must be found.

Special teaching machines for the young age groups are already manufactured by a number of companies, but probably the most extraordinary device is that developed by the Mc Graw Edison Company for Dr. Omar Khayyam Moore, a Yale sociologist. The device is a talking typewriter which speaks each letter as it is typed and also simple words.(455a) Very young children have been taught to read, spell, write, and type by virtue of their own curiosity when left alone with the talking typewriter. Projected displays present simple problems once the learner has familiarized himself with the machine so thatthree year olds can aquire verbal skills usually associated with older children ~~higher age groups~~.

The computer is presently regarded as the ultimate in teaching machines, and several groups are now investigating its potentialities. These include the System Development Corporation, University of Illinois, International Business Machines, and Bolt, Beranek, and Newman. All are using large general purpose computers capable of handling many students at different stages of the program simultaneously. Advantages already evident include the extensive branching capability, and the collection and storage of large masses of data for evaluating student progress, and for deciding which item or branch should be presented next. The ease of ~~making~~ obtaining item analyses and other statistical data makes the computer presentation especially valuable for research.

In 1959 the System Development Corporation developed an experimental teaching machine consisting of a random access slide viewer controlled by a Bendix G-15 computer. A typewriter was used for student responses, and also to present additional instructions and reinforcement. This device is shown in Figs. .

454,455,456,457,458

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Fig. .

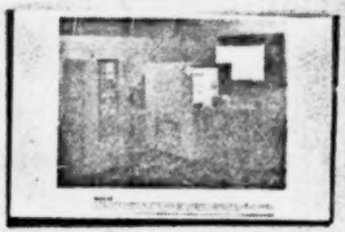


Fig. 458 stet System Development Corporation Computerised Teaching Machine. The computer controlls the sequence of slides presented, and analyses the student responses made on the typewriter.

Fig. stet 456a Automated Classroom. This research facility has facilitated the study of programing variables and student behavior in this new learning environment.

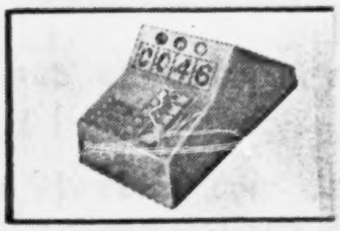


Fig. 456b Experimental Response Unit. Program is chosen by the buttons on the left, and responses made using the buttons on the right. Pushing the "Enter" bar enters it into the computer, and the numbers at the top tell the student which is the next frame.

It was used primarily to determine the required characteristics of a computer operated teaching system, and also to experiment with different forms of programing,~~xxx~~ presentation, and reinforcement. Most of this work was accompished with a program on Logic for first year college students.

The experience and design data obtained with this single machine was used to develop an automated classroom and simulation facility called CLASS. The classroom had 20 student positions, each with a response unit connected to a Philco 2000 computer. Programs could be presented in a group mode using slides with synchronized sound on tape, or films, over ~~a~~ closed circuit television, ~~system,~~ or by the classroom teacher directly. Individual learning was effected by books for simple programs~~,~~ and microfilm viewers for the more complex programs, the answers in all instances being keyed for multiple choice responses to be recorded and evaluated by the computer.

Four different programs were developed to explore the programing variable with different kinds of subject matter and at different grade levels. ~~In this way~~ Further information ~~on~~

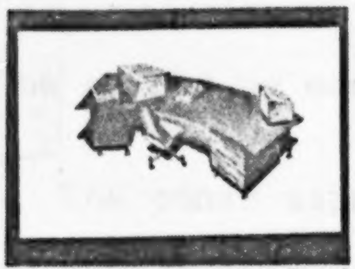


Fig. 457 Automated Teachers Desk, SDC.

The teacher can monitor the responses of any student, and has direct access to the students history and response data stored in the computer

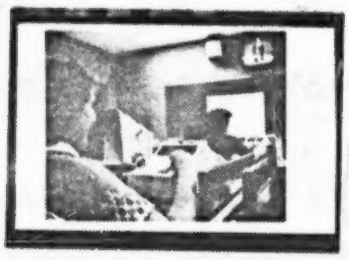


Fig. 458 Ctw Student Station in the SDC Facility.

Lessons are presented by book, filmstrip or television. In each case sequencing, data recording, and feedback is accomplished by means of the computer.

could be gained by modification of the program.

The other aspect of this facility was its ability to simulate for the student, teacher, and administrator the operation of a school using auto-instructional techniques. One-way mirrors allowed the researchers to study ~~individual~~ student reactions to this new kind of environment, while the teacher ~~has a~~ learned to use a variety of equipment to ~~allow~~ monitor~~ing of~~ ~~a~~ student~~'s~~ responses~~, or to~~ and call up information on scholastic record or recent performance on a computer generated display. Similar displays are also available to the counselor and principal to provide data for discussion and decision making with regard to any particular student. It has been found that a computer of this type would serve the needs of several hundred students simultaneously in addition to the recording and counseling functions. In short, a single computer could handle the needs of a whole school system.

International Business Machines ha~~ve~~s been using ~~their~~ its RAMAC 650 computer (fig 459) to study the differ~~ent~~ing programing requirements for ~~different~~ various subject matter, along with different ~~means~~ modes of

Fig. 459 IBM RAMAC 650 Computer used as a Teaching Machine.

Fig. 460 Modified IBM typewriter serves as the response unit, while the machine feedback is also via the typewriter

Fig. 461 Special Electroluminescent Display and Keyboard developed to teach stenotyping.

presentation and reinforcement. Typewriters (fig 460) ~~(xxxxx were~~ are used as ~~a means of~~ to communicat~~ion~~ with the computer, but to save time in presenting long items, the programs ~~were~~ are printed in book form. ~~Thus~~ The computer ~~was~~ is used to sequence the questions and evaluate responses. Some additional features were ~~added~~ found necessary for teaching machine use, notably a prompt button where the student needed a clue, a rest button, and a dictionary button allowing a student in a language program to use the computer for dictionary assistance by simply typing in the word. It was found that different ~~kinds of~~ programs required differ~~ent~~ing organization according to the requirements of the subject matter. In the case of a stenotype program, a special stenotype input was developed for the computer, and an electro-luminescent display was used to present problems and record performance. (fig 461) The programs in each case were designed to promote a maximum of "conversational interaction" between student and tutor (computer) to maximize motivation and reinforcement.

~~(measured response time in addition to right or wrong, prompt or no)~~

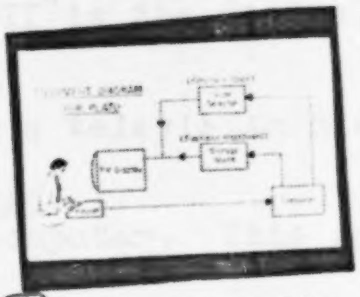


Fig. 462 Plato Schematic. The computer selects the next slide gram for presentation on the télevision viewer.

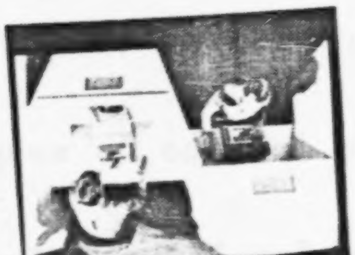


Fig. 463 Students work individually in separate booths.

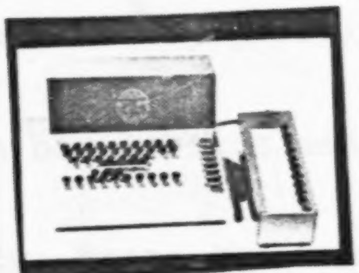
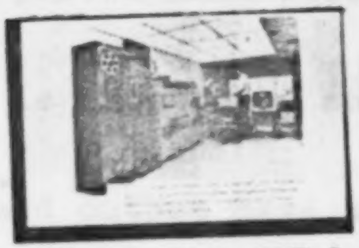


Fig. 464 Response devise used with PLATO. It is in effect a typewriter with some extra function buttons. Because the numeral keys are used more fsequently, the numbers are the front row of buttons

(figs. 462,463,464)

Plato II is the device developed by the University of Illinois using a television display and a special typewriter input to the ILLIAC computer. This system has some novel features in that the student's answer appears on the screen as he types it, and on pressing the "score" button, "yes" or "no" appears alongside his response. The program consists of a fixed main sequence with remedial sub-routines, and the student has a large degree of control over the sequence due to the inclusion of "help" and "aha" buttons. If he does not understand the problem he can have further instruction before answering the question by pressing the "help" button. However, should he gain a new insight and want to attempt the question he can at any time press the "aha" button which returns him to the question on the main program.

Bolt, Beranek and Newman Inc have programed a Digital PDP-1 computer (fig 465) for teaching drill materials, including French, Latin, and German vocabulary. Prompting and reinformement are varied according to the needs (or preference) of the student, and a novel method of scoring allows the learning experience



50% red

**Fig. 465 Digital PDP-1 Computer used by Bolt, Beranek, and Newman to study presentation variables in programed instruction.**

to become a sort of game or contest with the computer. This experiment has proved that access time ~~in~~ getting information to the student is important, so that programs using the typewriter as both input and output have adopted ~~abbreviations~~ symbols like + and − for right and wrong, and similarly for other commonly used words. Real advances in learning have resulted from the use of television ~~type~~ displays which allow more rapid presentation of questions and answers, and tie up less computer time. The cathode ray tube also allows graphic depiction of equations, etc., ~~and this~~ an area that has yet to be explored.

The Thompson Ramo Wooldridge MENTOR teaching machine has been already mentioned on p. 20. It uses ~~thx~~ a small special-purpose computer to ~~xxxx~~ evaluate responses and determine the item sequence using words, ~~and~~ sounds, ~~and~~ pictures, and motion pictures.

The computerized teaching machines mentioned in this section use large general-purpose computers to ~~sever~~ serve the needs of many students simultaneously. Although computer time can be saved using the group mode of presentation, their real advantage lies in their ability to tutor student~~s~~ individually, and to modify the program according to his immediate needs.

It should be noted that although it is possible to store the program in the bowels of the computer, it is advantageous for the moment to use books, microfilm viewers, or slides presented by television. Other possibilities, such as storing the various images on videotape, have yet to be explored.

For school operation the use of typewriter link to the computer would be too costly, but simple input-feedback units involving multiple choice responses could easily be programed to operate with a centralized data processor, using the programs in book or microfilm form. Quite a small computer could adequately handle the requirements of school, in addition to performing functions for administration and the business office.

The logistic problems of branching programs with unlimited use of sound and picture have yet to be overcome. To skip over sound or motion sequences running perhaps a minute or two in length would require quite expensive projection equipment, and so far no projector exists which allows immediate access to a range of sound motion picture sequences. Perrin and Luxton at the University of Southern California have a prototype machine using four motion picture units to simplify the access problem. One projector shows a picture, while the other three are either searching or waiting so that the appropriate branching sequences are available when the question frame is reached. The device is interesting in that it can accommodate constructed as well as multiple-choice responses, and is particularly well suited to the "linear with branching" form of sound film presentation.

## TEACHING MACHINES

### Programing media

**PAPER**
- book
- paper sheets
- cards
- discs
- roll
- fan-fold

**FILM**

| | | | |
|---|---|---|---|
| slides | | | |
| film-card | 35mm | 16mm | |
| film-strip | 35mm | 16mm | 8mm |
| motion picture | | 16mm | 8mm |

**TELEVISION**

PSYCHOMOTOR e.g PASH

### Response

- Written
- push button (pull-tab, scrape off, punchboard)
- typewriter
- light pen

### Feedback

student comparator — correct answer presented for comparison by student
machine comparator — colored lights — SOUND – CLICK, BELLS, & BUZZERS
- program automatically advances
- program advances to feedback frame (in branching)
- typewriter prints out relevant information

### Scoring

- student operates counter
- automatic counter
- loaded score and/or frame sequence
- machine evaluation of performace

### Mechanical features

- page turners
- control devices (answer mask, one way rachet, etc.)
- automatic comparator
- automatic advance
- random access
- memory functions (a. scoring, and b. tabulation of data)
- computerized (adaptive) machines
- ability of machine to generate new program material
- sound complement and multi-sensory devices
- CLASSROOM COMMUNICATION SYSTEMS

# TEACHING MACHINES

✓ A-Alpha Pattern and Manufacturing Co.
3523 E. 4th Street
Los Angeles 33, Calif.

✓ Aircraft Armaments, Inc.
Cockeysville, Md.

✓ American Teaching Systems, Inc.
12902 S. Broadway
Los Angeles 61, Calif.

~~Applied Educational Systems~~
~~110 Edison Place~~
~~Newark, New Jersey~~

✓ Astra Corp.
19 Burton Ave.
Norwich, Conn.

~~Astra Corp.~~
~~31 Church Street~~
~~New London, Conn.~~

Automated Teaching Systems, Inc.
1 West 58th Street
New York, New York

Auto Instructional Devices
12 Manheim Road
Essex Falls, New Jersey

✓ Avta Corp.
3450 Wilshire Blvd.
Suite 512
Los Angeles 5, Calif.

✓ Cenco Instruments
1700 Irving Park Road
Chicago 13, Ill.

Chapman Teaching Machine
12231 Singingwood Drive
Santa Ana, Calif.

✓ Cinescopes Products Co.
P.O. Box 8403 Crenshaw Street
Los Angeles 8, Calif.

Colortone Press
2400 17th Street N.W.
Washington 9, D.C.

Comparator - See Larsen Teaching Machine

Devereux Teaching Aids
Box 717
Devon, Penna.

✓ Diamond Electronics
Lancaster, Ohio

Digital Equipment Corp.
146 Main Street
Maynard, Mass.

✓ Dorsett Electronics, Inc.
119 W. Boyd
Norman, Oklahoma

✓ DuKane Corp.
St. Charles, Ill.

✓ EDEX Corp.
3940 Fabian Way
Palo Alto, Calif.

✓ Ed-U-Cards Manufacturing Co.
13-05 44th Ave.
Long Island, New York

✓ Educational Aids Publishing Corp.
Carle Place Post Office
Long Island, New York

~~Educational Developmental Laboratories, Inc.~~
~~Huntington, New York~~

✓ Education Engineering Associates
3810 Pacific Coast Highway
Torrance, Calif.

✓ Educational Specialities Co.
Murray, Iowa.

✓ Electronic Teaching Laboratories
5034 Wisconsin Ave.
Washington 16, D.C.

E-Z Sort Systems, Ltd.
45 Second Street
San Francisco, 5, Calif.

✓ Field Enterprises Educational Corp.
Merchandise Mart Plaza
Chicago 54, Ill.

FMC Corp.
~~633 3rd Ave~~
~~NY 17.~~
1185 Coleman Av
Santa Clara, Calif.

Foringer and Company--See Programmed Teaching Aids

✓ General Atronics Corp.
One Bala Ave.
Bala-Cynwyd, Penn.

✓ General Education, Inc.
96 Mt. Auburn Street
Cambridge, Mass.

✓ Gilfillan Corp.
1815 Venice Blve.
Los Angeles 6, Calif.

~~Graficroll Systems~~
~~4215 Calavo Drive~~
~~La Mesa, Calif.~~

✓ Graficroll Systems, Inc.
660 Steele Street
El Cajon, Calif.

✓ Graflex, Inc.
Rochester 3, New York

✓ Hamilton Research Associates, Inc.
New Hartford, New York

✓ Honor Products Company
316 So. Sixteenth Street
St. Louis 3, Mo.

✓ HRB SINGER, Inc.
Science Park, P.O. Box 60
State College, Penn.

Videosonic Systems Division
Hughes Aircraft Co.
P.O. Box 3310
Fullerton, Calif.

✓ Hunter Manufacturing Co., Inc.
P.O. Box 153 Coralvisse Branch
Iowa City, Iowa

✓ Industrial Electronic Engineers, Inc.
5528 Vineland Ave.
North Hollywood, Calif.

✓ Info-Tron, Inc.
P.O. Box 10745
St. Petersburg 33, Florida

✓ Instruct~~ional~~ive Devices
8545 Academy Station
Albany 8, New York

✓ Instrument Research Co.
12031 Euclid Ave.
Garden Grove, Calif.

International Business Machines

✓ Jansen Electronics Manufacturing, Inc.
2285 University Ave.
St. Paul 14, Minn.

✓Gerald L. Jensen
1267 Wensley Ave.
El Centro, Calif.

Charles W. Kiker, Jr.
P.O. Box 546
Blue Ridge, Ga.

✓ Kunins Engineering Co.
1730 Popham Ave.
New York 53, New York

✓ Larsen Teaching Machines
P.O. Box 452
Petaloma, Calif.

✓Lectron Corporation of America
9929 W. Silver Springs
Milwaudee, Wisconsin

Management Research Associate
185 N. Wabash
Chicago 1, Ill.

~~The Marquardt Corp.~~
~~Technical Director's Staff~~
~~2709 N. Garey Ave.~~
~~Van Nuys, Calif.~~

✓Mast Development Co., Inc.
2212 E. Twelfth Street
Davenport, Iowa

✓Minneapolis-Honeywell Regulator Co.
1017 Wilshire Blvd.
Los Angeles 17, Calif.

✓Modern Teaching Associates, Inc.
1506 West Pierce Street
Milwaukee, 46, Wis.

✓MultiMatics Machines, Inc.
1355 Muirlands Vista Way
La Jolla, Calif.

NAK Inc.,
Santa Barbara. Airport,
Goleta, Calif.

National Blank Book Co.
2829 Water Street
Holyoke, Mass

✓National Communication Laboratories
507 Fifth Ave.
New York , New York

✓National Educational Systems, Inc.
9250 Wilshire Blvd.
Beverly Hills, Calif.

Needs Corporation
225 W. Euclid Ave.
Jackson, Mich.

Nortronics Division, Northrop Corp.
222 North Prarie Ave.
Hawthorne, Calif.

Palmer Learning Aids
600 South Michigan Ave.
Chicago 5, Ill.

Paromel Electronics
3956 Belmont Ave.
Chicago 18, Ill.

✓ Perceptual Development Labs
6767 Southwest Ave.
St. Louis, 17, Mo.

Plato – see Univ. of Illinois

✓ Programmed Teaching Aids
3810 S. Four Mile Run Drive
Arlington 6, Va.

✓ Publishers Co., Inc.
1106 Connecticut Ave. N.W.
Washington, D.C.

✓ Recordak Corp.
Wanamaker Place
New York 3, New York

Renner Incorporated
1530 Lombard Street
Philadelphia 46, Penn.

Responsive Environments Corp
21 E. 40th St
New York 16, N.Y.

✓ ~~Renner Incorporated~~
~~10955 West Pico Blvd.~~
~~Los Angeles 64, Calif.~~

✓ Rheem Califone Corp.
5922 Bowcroft Street
Los Angeles 16, Calf.

✓ Rheem Electronics
Division of Rheem Manufacturing Company
5200 W. 104th Street
Los Angeles 45, Calif.

~~Roto-Vue Model Publishing~~ Co.
~~Room 1212 Holland Building~~
~~211 North 7th Street~~
~~St. Louis 1, Mo.~~

Smith-Harrison, See [illegible]

Standard Projector and Equipment Co., Inc.
7433 N. Harlem Ave.
Chicago 48, Ill.

J.B. Staten
Box 44
Bay City, Texas

System Development Corporation
2500 Colorado, Santa Monica, Calif

Teaching Machines, Inc.
235 San Pedro N.E.
Albuquerque, New Mexico

Teaching Materials Corp. see Teaching Machines, Inc.
~~Sales Department~~
~~575 Lexington Ave.~~
~~New York 22, New York~~

Teleprompter Corp.
50 W. 44th Street
New York 36, New York

Thompson Ramo Wooldridge—see ~~[illegible]~~ Chapman

Tutor Tape Laboratories
770 LEXINGTON AVE
NEW YORK 21, N.Y.

Universal Electronics Laboratories Corp.
510 Hudson Street
Hackensack, New Jersey

USI Educational Science Division
250 Park Ave.
New York, New York

University of Illinois

VanValkenburgh, Nooger and Neville, Inc.
15 Maiden Lane
New York 38, New York

Viewlex, Inc.
Holbrook
Long Island, New York

Visual Programing, Inc.
315 Central Park West
New York 25, New York

Visutronics Corporation of America
232 Las Vegas Blvd., So.
Las Vegas, Na.

William Research Corp.
P.O. Box 95
Walled Lake. Mich.

Note: Mentor - query